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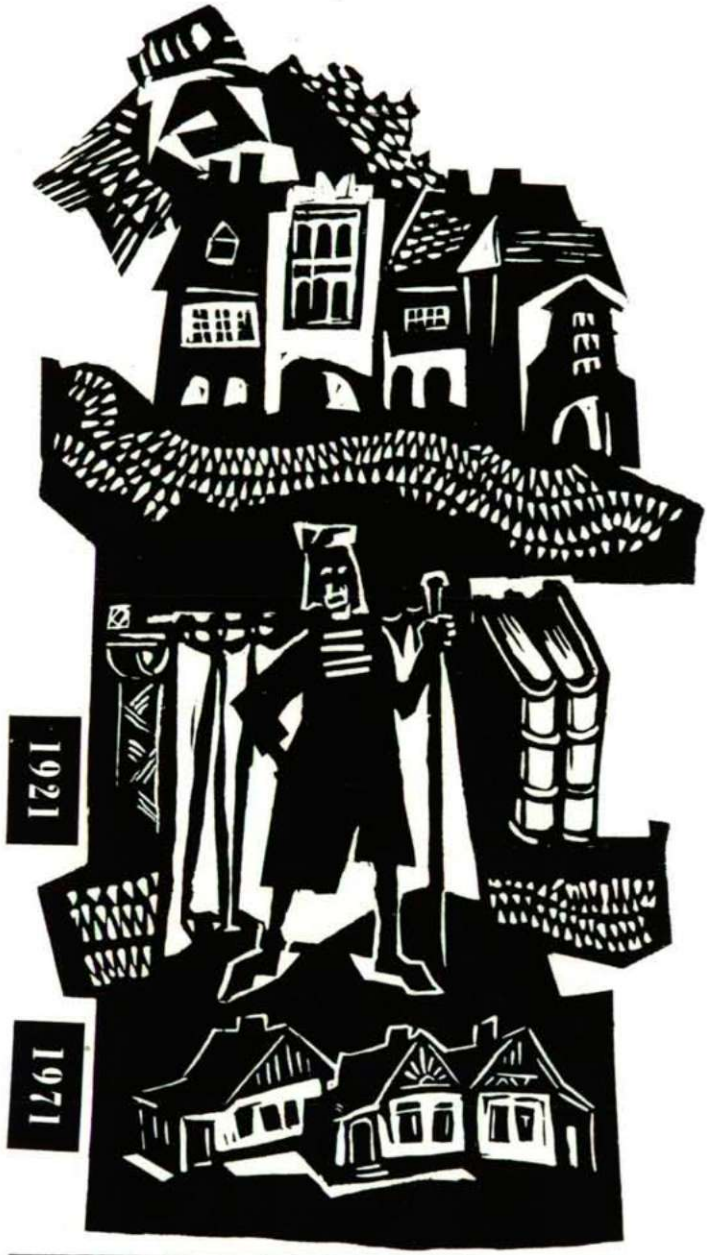
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The Biological Committee of the Attila József University and the Szeged Division of the Hungarian Biological Society held a joint meeting of the LENIN centennary commemoration day on April 16 1970. After the inaugural address of Chairman Prof. Dr. IMRE HORVÁTH, there were delivered two lectures: Dr. I. MARÓTI and Dr. MÁRIA HORVÁTH: Paradoxes in biological structures and Prof. Dr. L. MÓCZÁR: Ethnolische Ergebnisse an *Hymenopteren.*

SOLEMN SESSION OF THE ATTILA JÓZSEF UNIVERSITY HOMAGE TO LENIN

(Presidential inaugural address.)

I. HORVÁTH

The Biological Committee of the Attila József University and the Szeged Division of the Hungarian Biological Society held a joint meeting on the occasion of the LENIN centennary commemoration day on April 16 1970. After the inaugural address of Chairman Prof. DR. IMRE HORVÁTH, there were delivered two lectures: DR. I. MARÓTI and DR. MÁRIA HORVÁTH: Paradoxes in biological structures and Prof. DR. L. MÓCZÁR: Ethnologische Ergebnisse an *Hymenopteren.*

The centenary of birth of the greatest genius of progressive mankind is celebrated all over the world in these days. Lenin's theoretical and political activity developed at the time as capitalism got to the final stage of its evolution, and as the epoch of proletarian revolutions, the transition of historical significance from capitalism to socialism began. The great theoretician of these social revolutions and the leader of the Great October Socialist Revolution was VLADIMIR ILITCH LENIN.

The modernization of the methodology, philosophical bases of Marxism was demanded by the strategy and tactics of Revolution. One of the manifestations of LENIN's creative genius was to have recognized and solved that problem. He developed and enriched the dialectical and historical materialism of Marx and Engels, criticized and revealed the idealistic and metaphysical opinions.

LENIN's idea that natural sciences and philosophy are closely related is of epoch-making significance. LENIN was the first philosopher who recognized in the results of natural sciences — taking his illustrations often from biology — the beginning of a vast scientific revolution that culminates in the socialist society, serving development and prosperity of mankind.

Scientists and scholars can render homage to LENIN's memory in the most decorous way by going in the branches of their science to the best of their

knowledge, developing them creatively, taking into, consideration the demands of society, too, and not forgetting to promote the connections between natural sciences and philosophy.

These tendencies are reflected in our festival session, as well.

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PARADOXES IN BIOLOGICAL STRUCTURES

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(Received July 20, 1970)

Great men, answering the intricate questions of our age, showing the way of social development and leading the struggle for a higher development are fulfilling a prominent historical role. This is a known thesis of Marxism, very apt to quote when we are commemorating the centenary of LENIN's birth.

Prominent personalities who have rendered with their activity a considerable service for mankind have inscribed their names in the book of history for centuries and millennia, perhaps ever. LENIN belongs to these latter.

There have lived few people on Earth whose memory was as much enthroned in the hearts of peoples as his. The veneration of peoples for his personality and life-work is growing more and more like a revolutionary force transforming the world.

The French writer, Barbusse, has written about him, in the same way as MAYAKOVSKY, that LENIN is the YESTERDAY, the TODAY, and the TOMORROW.

The new epoch in the development of Marxism that began at the turn of the 20th century is connected with LENIN's name.

He substantiated and developed the dialectical and historical materialism, — making us acquainted with the dialectical materialism in the light of scientific results.

He gave a positive form to the fundamental problems, to those of matter and motion; space and time; causality, liberty, necessity and development, and the theory of reflection, being all of dialectical character.

There are particulalry important the theorems concerning the elaboration of dialectics in the light of logic and modern epistemology.

In accordance with our subject-matter, we are setting forth the law of unity and struggle of antinomies.

LENIN called the theory of antinomy the „nucleus" of Marxian dialectics, giving a clue for understanding every moment and side of development.

There is based upon the law of unity and struggle of antinomies also the reciprocity of content and form, essence and appearance, chance and necessity, etc. This is why this law is so important in dialectics.

The relation with that law is the criterion that decides whether a theory is scientific and vigorous or not, and it is not a mere chance that the anti-Marxist literature is impugning mainly this teaching.

The Marxian dialectics is starting from the principle that it is a property of every thing and phenomenon to have an inner antinomy for all things and phenomena in the nature have negative and positive sides, past and future, declining and developing components, the struggle of these contrasts forming the inner content of the process of development, that of quantitative changes as they are transformed into qualitative ones.

Both members of the contrast pair, the internal and external ones, continuity and intermittence, are preconditions of each other, are existing only in a unity with the other.

If there were no internal contradictions in things and phenomena, if there were no struggle between opposite sides and tendencies, so the things and phenomena would remain unchanged, any development would be impossibles, any qualitative change and everything would remain in a state of stagnation.

If the progressive classes of society did not carry on a struggle against the obsolescent classes then their conflicts would not be solved, the society could not make progress. Marxism is therefore averse to the ideas of a harmony between antagonistic classes.

Class struggle is an objective rule of a society broken up into hostile classes. Therefore has LENIN said, characterizing the essence of development, that development is the struggle of opposites.

This definition gives the driving force of development.

The antinomies are — the complicated processes of contradictions in their state of rising, developing and being solved.

In the course of development, the difference turns into opposite, i. e., into a more developed contradiction in which the two sides of contradiction are already separated from each other.

The phase of solving the antinomies plays an extremely important role in development. The old one decays and the new one gains ground. In the complicated processes, an antinomy cannot be solved immediately after making its appearance.

Inheritance, i. e. the antinomy of accomodation cannot be solved suddenly. The contradictions must grow to a certain degree for inducing the preconditions of solutions.

Any unity of contradictions is but transitory, comparative. The struggle of contradictions is, however, not temporary but a factor having a standing influence, otherwise evolution would cease to be existing.

LENIN's teaching applied at analysing the dialectical development, as a dialectical thesis concerning the unity and struggle of antinomies, may be used also for understanding more generally the theoretical and philosophical questions of the biological structures, for establishing the general theses.

We are dealing now in this way with the peculiar character of unity and struggle of the contradictions contained in the biological structures.

The notion of the structure of living beings is containing several and, at the same time, special contradictions. In biology, structure has the same sense as a relation arranged exceptionally (in space and time) of the elements composing the phenomenon. This new notion of structure is, therefore, not the same as that of mechanism: it is not a kind of some unchanged passive skeletons being but some framework of changes that take place in the living beings.

The structure has functional and morphological sides; it means the endless struggle and relative equilibrium of these.

We are emphasizing here some particular characteristics of the contrast and unity of structure and function.

First of all the biological attraction and repulsion.

For producing a relation, connection, bond between the elements, we need in any case the contrast and unity of attraction and repulsion. The nature of chemical bond is based first of all on the attraction and repulsion of the electrons with contrary spin: co-valent, ionic, metallic, hydrogen bonds. In the living beings, of course, also the contrast of chemical attraction and repulsion is always present, manifested in the living structures, anyway, in a new quality, as an attraction and repulsion of so far mostly unknown nature.

In the biological structures, also the attraction and repulsion recognized till now manifest themselves in several new shapes. The high degree space-specificity of macro- and supra-molecules (proteins), (nucleic acids), the enzymosis are the basis heredity. In the mitochondria, e. g. the very high speed of respiratory reaction, the immediate transformation of energy (without ATP) are ensured by being arranged spatially and temporally. In the vectorial character of the enzyme effect, too, the particular nature of attraction and repulsion is manifested: the active sites, the anisotropic surfaces having selective chemical affinity are examples of the contrast of co-existence and separation.

All these peculiarities cease to exist or highly decrease if the enzymes (proteins) get in solution. This is an explanation for the new effort of more and more investigators to study the molecular forces on models of solid phase.

The comparatively weak bond between the elements of biological structures — that may be connected with the greater distance of the single elements from each other — manifests itself in an increased sensitivity to light, heat, and pH. It is to be emphasized that the word macro- or supra-molecule — in contradistinction to its etymological meaning — is not only meaning a giant molecule but a category of matter differing qualitatively from molecules.

In biological structures, the development of contrasts: — difference — the well-developed phase of attraction and repulsion — solution of the antinomy, its attainment of relative balance — is regulated; it results but rarely in an antagonistic contrast — the reciprocal change of the place of opposite sides is a frequent solution.

The development of contrasts is carried out by a highly organized regulation of especially separated components of structures in various levels; — these are, almost exclusively, at the service of regulation. The accidental processes in the organization of biological structures become necessary owing to being regulated.

The open and closed organization of structures is connected with that the living beings are forming, from the point of view of metabolism and development, a self-regulating open system. On the other hand, the components, part-structures that build the structure are closed qualities. Their closed state is shown by that, in the whole living world, the single levels of organization are formed by only a few elements of finite number. Chemists have produced about 2—300 kinds of amino-acids while in the living world there are only 20 of them. Nucleic acids are composed of four bases. In the plastid of every plant — however, great differences may be between the plastids of the single taxons in structural and functional respects — the proteins are similarly composed of the same amino-acids. The organization

is open, and the single ortanizational levels appear as a contrast of its being closed. The fact that proteins are composed of only 20 sorts of aminoacid is not a proof of the lack of fantasy in nature but these seem to be the most suitable of all the possible components as regards both their number and quality.

An open organization or development is, therefore, not pre-established first of all by quality and number of the components but by their spatial and temporary relation of an almost inexhaustible variation.

If we investigate the unity of the contrast of asymmetry and symmetry from the antinomies of living structures, then:

Asymmetry is meaning that the molecules of organic matter contain the same atomic groups; the spatial arrangement of these atoms, atomic groups is, however, different on account of which a definite equality of the right and left antipodes may be observed.

The structures composing the living being are not only asymmetric but even the symmetry is characteristic of the structure of several components.

Carbon atoms have a homogeneous energetic symmetry, their electron shell showing a characteristic inclination to polarity.

The organic compounds advancing towards being alive have differed from the others in optical activity as nearly every component of the living matter is leftspinning and not racemic.

In the living being, symmetry and asymmetry, these structural properties of opposite character, do not exclude each other; on the contray, they both are indispensable structural properties from the point of view of life. Therefore, we find their simultaneous, contemporaneous existence in the structural units of life on the various levels.

The carbohydrate molecules that are always present in the living being are generally left-spinning. The carbon atoms, however, that take part in composition of molecules show certain kind of symmetry.

The contradiction observed in the structure of protein, the most important component of living matter, is similarly connected with the phenomenon of asymmetry.

Symmetry and asymmetry as a fundamentally important structural contradiction can be found not only on the level of the elements and compounds composing the living being but also on that of higher structures. In the whole animal kingdom there came about an almost unparalleled asymmetry. And in plants we also find asymmetry. Notwithstanding symmetry is also found both in plants and animals. The unity of symmetry and asymmetry changes in the course of ontogeny; in an early phase there is a perfect symmetry, later on, however, a series of asymmetries develops.

Emphasizing the unity of structure and function, we may not leave the development out of consideration. There is not really any absolute conformity between structure and function. The present degree of conformity is a result of a long historical development where the reciprocity of structure and function conduced to the present degree, in addition to the inner and outer conditions being determined.

The unity of structure and function, like any dialectical unity, is contradictory. The contradictions can be approached from different sides.

We may lay stress on the contradiction between structure and function.

We have so far said that they are forming a unity presupposing each other reciprocally. They turn into each other reciprocally in the sense that the structure is functioning and function brings about a structure or modifies it. Structure and function contain, besides unity, also the relation of mutual exclusion.

As a result of the uneven development of structure and function, a contradiction takes place between them. As a consequence of the reciprocal influence of the structure as a whole and its part structures, as well as of the structure and external world on each other, there may change primarily either the function or the structure at one of them while the other factor retards. And that can be a source of contradiction, too.

It occurs that the structure of a function that already ceased to exist survives in the form of atrophied organs. But it is more frequent that the structure falls somewhat behind the functions. A function, however, does not creat in itself any structure. The new structure and function come about on the basis of the contradiction of the structure and function opposed, the old ones being rendered unnecessary in that way.

The unity of structure and function modifies as function may detach from structure, and the structure itself can be contradictory to its own function in the sense that upon a comparatively simple structure there can be based a rich multiplicity of functions. The structural elements of proteins and nucleic acids are not as diversified as the macro-molecules composed by them concerning their functions and the amount of information stored in them.

The realization of function as that of some phenomena of life takes place to the account of the structure.

Every phenomenon of life needs some energy produced by the living being to the account of the structure — that is the production of energy, decomposition, reconstruction.

The consistence of protoplasm is contradictory in itself. It is representing a transitory state. On the surface of protoplasm physical and chemical processes take place functioning as a result of contradictions. There are contradictions in the structure of protoplasm like attraction and repulsion.

Among the contradictions of the components of structure as well as among those maintaining the structure there are to be found the pH-relation and the ion-antagonism, as well.

Inside the living being, there is the contradiction of DNS and RNS, two concerte structures of fundamental significance.

If we take into consideration that the replicative ability of a DNS molecule is based fundamentally on the sequence of bases and this sequence on the contradiction in structure, then it is evident that this is the most important example.

In the process of protein synthesis, there steps in again some contradiction: a state comes about that is suitable for the biosynthesis of protein, and this state is based on the unity of the acidic-basic contradiction of compounds.

The existence and character of function is determined by the structure if we are now not taking notice of the reaction. There is, consequently, not only the structure but the function, as well, of contradictory character.

We are meaning by the contradiction observed in the functions of a living organism not a pathological decompositions of the conarted action of the organism — although this may be a type of contradictions, as well, as that forming the inner content of decay or decomposition — but the contradictions stepping in the normal functioning that is the inner concent of ontogeny and of the development of genotype.

In the living being there are a lot of structures on different levels performing a very great number of functions, the totality of these functions in their high-degree co-ordination meaning life itself.

We cannot demonstrate the antinomy of every function but are investigating only a few of them.

Structure and function as a pair of contradictions are not similar to the pair white-black but to those right and left, old and new in a sense that the notion of white or black can be defined objectively even independently from each other while structure and function cannot be separated from each other. Function is the „own counterpart", i. e. contradiction of structure and it is also vice versa, they do not exist without each other and turn into each other mutually.

In biology and medicine, function is often interpreted mechanically. In classical physiology, function means the activity, work of a cell, tissue or organ that is perceptible externally. The various interpretations of function can be summed up with a simplification:

Function is considered as a purpose of a structural formation, as a passive result of its existence: we speak about a protective function in plants in connection with thorns and spines, in insects in connection with the chitin cover, in snails in connection with shell, horn.

Another notion of function is the activity, work of an organ that can be appreciated externally: e. g. the flying function of a wing, holding function of a hand, digestive function of the stomach.

According to a notion of function generally accepted by philosophy and special sciences, function is one of the manifestations of metabolism. This definition is emphasizing one of the most characteristic properties of the living being but in the course of recognizing it often the „manifestation" becomes first known having the appearance that the cycles, processes, functions come about „without background", „pure" and structure-free.

According to the view of molecular biology, in the relation of structure and function at emphasizing the structure there are dominant, first of all, the extensity, the morphological sings, and at emphasizing the function the temporal character, process, cycle and rhythm. In this conception, based on the unity and struggle of contradictions, it becomes more and more obvious that structure and function as two sides of a contrast-pair are not only inseparable but also indefinable without each other.

Metabolism as a fundamental function of life is of contradictory nature, anabolism and katabolism are two sides of a circulation presupposing each other reciprocally. Composition and decomposition are processes with contradictory results; releasing and consuming energy, they cannot exist without each other and form the two sides of the same function.

A further contradictory character of the part-processes of metabolism is shown by the enzyme activity without which there in no metabolism. For transforming a matter, first of all proteins, that are extraneous to the species into species-specific matter during the intermediary metabolism, the organism has to decompose them into their components. This part is acted by the enzymes and we can observe also in their activity a contradictory motion, of promoting and inhibiting character.

A peculiar form of the enzyme and the inhibiting matter is shown by the contradiction, the competitive inhibition.

The contradictory nature applies to the enzymes themselves, as well, e. g. as the same enzyme can catalyze processes of contradictory direction.

There belong to the contradiction of metabolism also the problems of regulation. In plants, there are the contradictions of auxin, gibberellin, cytochinin, in animals those of the functioning of the neuroendocrine system. Without regulating mechanisms the normal course of metabolism is not ensured. The regulatory substances are capable of contradiction, of contradictory effect. In a low concentration stimulation, in high concentration inhibition has been observed.

The contradiction of the production and transformation of energy that is unit of metabolism is a peculiar contradiction both in the content and in the form of the living world.

This problem had been investigated as we had analysed the function. Here we are going on. The most important function of the living being is the metabolism that contains a number of detailed functions. Now we have to clear the problem whether metabolism and its contradictory sides are a peculiarity of the living world.

The literature dealing with the philosophical question of biology is using this notion in a wider sense than the special branches of sciences.

Metabolism is identical with intermediary metabolism. The latter is a molecular process forming the basis of the phenomenon of life. Intermediary metabolism means a chemical and physical molecular process that takes place in submicroscopical structures.

In a broader sense, metabolism means the whole circulation of materials in the living organism, with two main parts: the external and internal traffic of materials.

A characterization of metabolism like this is justified but the broader philosophical interpretation affects the connection of organism with its surroundings, as well. This philosophical interpretation is important for regarding the living being as an open system.

In connection with this wider interpretation there arise also the problems of „*Weltanschauung*". The intermediary metabolism does not give too great a possibility for a philosophical interpretation.

There arises on philosophical level only in this broader interpretation the metabolism as a peculiar connection of organism and surroundings, as well as the living being as an open self-regulating system. And at present it is only after making a distinction between metabolism and circulation of materials that the question may be posed if there exists a metabolism in society, and

whether assimilation and dissimilation are really a contradiction in the living world.

On the other hand, in the living being the exploration of the metabolic process means to recognize the most important peculiarity of the living matter. The contradiction of anabolism and katabolism can be placed therefore among the most particular antinomies that are characteristic only of living beings.

The living being, for preserving itself, has to carry out certain activity, namely: procuring and intake of food, transport in the organism, transformation, release of the energy stored to possess again the energy that is necessary for starting the whole process anew.

At the contradiction of structure and function we have already exposed from another side that the living organism releases and utilizes the energy stored in its own structure. A part of the external activity of living beings procures and takes up from the environment the matter they need.

Parallel with the organism being more developed a greater external activity takes place with a due differentiation for performing it. The external activity has also an internal side for mastering the environment that endeavours to have balance.

The contradiction of external and internal activities is similar to a whole series of contradictions discussed so far, e. g. to the contradiction of structure and function discussed above — where the contradiction has meant among others that the function takes place at the expense of structure annihilating it partly or entirely. And the problem is in connection also with the contradiction of organism and surroundings as the organism carries out the function against the activity of surroundings for an equalization. Life ceases to exist in the minute as the thermodynamic equilibrium whith the surrounding ensues.

For surviving, the organism has to perform a standing activity, work against the endeavour of the surroundings for obtaining balance.

The problem of an external and internal activity and work reminds us very much of the contradiction of assimilation and dissimilation. These two processes can be included in the notion of an external and internal circulation of material, as well as in that of metabolism. By characterizing the external and internal contradictions we have not repeated the above mentioned ones because the contradiction of its external and internal activities is a contradiction of the organism primarily in energetic relation, showing simultaneously from a new side the connection of organism and surroundings, illuminating the dynamical equilibrium and the unity of the balance and balanceless state.

From the functions that are characteristic of living beings, we may investigate the contradictions of multiplication, as well. We do not endeavour here to discuss every problem connected with the notion of multiplication. We are taking for basis zoogamy, observing the contradictions in the course of the union of spermatozoa, growing and development of the fertilized ovum.

At the starting-point of zoogamy, a contradiction is contained by the aggregation and division of cells. The two joining sperms contain several contradictions before uniting, e. g. in respect of the function, as well. It is very important that they are of contradictory character from genetic point of view, too. There is, at least, a difference on the level of being different, meaning

that inside some limits there joins a gene substance carrying the information of a genetic heredity differing from one another. If we consider that according to the genetic theory of evolution the source of variability is mutation, as well as the structural and numerical change in the chromosome number and the recombination together: a recombination cannot take place without uniting the sperms of the individuals with different heredity. It is obvious, therefore, that an important contradiction is in question not only from the point of view of fertilization but also from that of ontogeny and mainly from that of the development of the species, too.

The development of the new individual is not confined to growth similarly to other courses of evolution. There follows a differentiation, too. With that comes concerning the character of cells, the turning into their own contradiction, the process of differentiation.

Anyway, the result of the differentiation process of ovum becomes only suitable for a newer differentiation after being fertilized if previously it had dedifferentiated.

The thesis is therefore meaning differentiation that carries in itself also its antithesis: dedifferentiation.

The contradictions of structure and function, investigated together and separated, give some basis for theoretical conclusions.

Our first conclusion is: The structure is a base of function and as it is contradictory, accordingly, also the function is of contradictory character. This does not mean, however, that behind each of the functional contradictions there should be a structural one. Both function and structure have some relative independence and, consequently, similar functions can be carried out by different structures, too. The functional contradictions are, therefore, not immediately attached to a structure.

In the second place: It is equally characteristic of the contradictions of structure and function that every structure and function can conflict with another structure, respectively function — because a living being as a unitary whole consists of several intertwined structures and functions or of those penetrating one another, being in contradiction even with itself. That is in some extent identical with the problem of the external and internal contradictions, being in connection with the philosophical question whether the antinomy is a contradictory relation connected with identical or with different aspects. According to the functional investigation of structure, it is both of them.

In the third place: It is shown by the investigation of contradictions both in structural and in functional relations that the contradictions constitute the internal content of the existence, motion and development both of things and processes and there is no sharp boundary between the contradictions ensuring the existence and development of things. Polarity ensures the definite existence of a structure and it may be a starting-point for the course of vital processes with a polarized character.

In the fourth place: Investigating the different structural and functional areas, we are driven to the conclusion concerning the antinomies that the contradictions form a unitary chain in the living being. What we are talking about are not contradictions existing side by side but contradictions that are

interlocked chain-like and their connection has a diverging character. This means that whatever contradiction we may examine, one of the sides of the things or processes in contradictory relation is only the unit of contradictions known in themselves. If we take one of them, we shall discover a disintegration into newer and newer contradictions.

(Lecture delivered in the Biological Committee of the Attila József University, Szeged, and in the Department in Szeged of the Hungarian Biological Society.)

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ETHOLOGISCHE ERGEBNISSE AN HYMENOPTEREN

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(Eingegangen 8. 7. 1970)

Die überaus abwechslungsreiche Lebensweise der Hymenopteren bietet — unter allen Insekten — die ergiebigsten Möglichkeiten für ökologische und ethologische Studien. Im Laufe der Beobachtungen an dem Verhalten zahlreicher Arten der Unterordnung *Aculeata* und im Verlauf der mit ihnen angestellten Versuche trachtete ich Antwort auf die folgenden Fragen zu erhalten:

I. Wie verhalten sich die *Aculeaten* gegenüber äusseren Einflüsse im allgemeinen?

II. Passen sie sich den äusseren Umständen, ökologischen Einflüssen an?

III. Das Verhalten einer noch solitären, aber bereits in Gruppen nistenden *Hymenoptere* habe ich zwecks Klarstellung folgender Fragen eingehend analysiert:

1. Aus welchen Einheiten oder Einzelheiten besteht ihre Tätigkeit?

2. In welchem Verhältnis stehen diese zueinander? Sind sie locker oder fest miteinander gekoppelt?

3. Wie verhält sich die Wespe oder Wildbiene, wenn sie in ihrer Betätigungsserie durch exogene Faktoren gestört wird?

4. Ist das gruppenweise Nisten lediglich eine günstige lokale Gegebenheit oder eine Möglichkeit dazu, dass die Wespe oder Wildbiene, in ein anderes Nest eindringend, dort ihre unterbrochene Tätigkeit fortsetzt?

5. Setzt sie in dem fremden Nest die unterbrochene Handlungsreihe fort, oder aber diejenige die sich aus dem Zustand des neuen Nestes ergibt?

Der Kern Frage befindet sich eigentlich darin, ob im Laufe der genannten Vorgänge aus der solitären Lebensweise der Ansatz zu einem Gemeinschaftsleben hervorgehen kann, ob die Wespe sich in irgendwelche Arbeit des nicht-eigenen, d. h. fremden Nesten einfügt.

IV. Ein Beispiel für die praktischen Ergebnisse der Verhaltensstudien.

I. Jeder Sammler weiss, dass — wenngleich es auch weniger wachsame *Hymenopteren* gibt — der grössere Teil der *Aculeaten* während der Nahrungsaufnahme ziemlich wachsam ist. Bereits aus einer Entfernung von einigen Metern begeben sie sich in die Flucht. Die nach dem Nistplatz suchende *Odynerus*-Wespe irrt stundenlang an der Lösswand herum und beginnt wiederholt ein Loch auszuscharren. Es genügt jedoch eine raschere Annäherung oder eine plötzliche Bewegung, um sie von dem begonnenen Nestbau wegzuscheuchen. Lässt man sich aber in der Nähe einer nestbauenden Wespe nieder, während diese bereits die Röhre verfertigt, so wird sie bei einer Bewegung zwar aufgescheucht, fliegt jedoch bald zurück und setzt ihre Arbeit fort. Den einen Fuss einer gelähmten Spinne hielt ich mit einer Pinzette, den anderen Fuss hielt die Wespe! Ich habe sogar mit der Hand einem *Odynerus* die als Larvenfutter eingebrachte Afterraupe weggenommen, ohne dass dieser sich in seiner Arbeit

hätte stören lassen. Wenn jedoch das Ei bereits abgelegt und das Nest verschlossen ist, wird die Wespe wachsamer. Mehr als einmal geschah es, dass die Wespe endgültig ihr halbwegs verschlossenes Nest verliess, wenn ich während der Fotoaufnahme der letzten Etappe der Nestverschliessung eine zu rasche Bewegung machte. Die Wespe reagiert also elastisch auf äussere Reize. Je näher der Zeitpunkt der Eiablage heranrückt, um so stkärker wird das Abwehrvermögen gegen äussere Reize zurückgedrängt. Ihre Reaktion steht also im umgekehrten Verhältnis zu der Nähe der Eiablage.

II. An der Lösswand zu Tihany nistet massenhaft auch *Anthophora parietina* var. *fulvocinerea* DOURS. Im Mai 1960 fand ich ein *Anthophora*-Nest, das auf ein *Paragymnomerus spiricornis* SPIN.-Nest, auf dessen abgebrochene, stummelhafte Röhre, aufgebaut war (MÓCZÁR 1961c). Als Beleg habe

Fig. 1. *Anthophora parietina* var. *fulvocinerea* DOURS. baute die Flugröhre seines Nestes am Lösswand in Tihany auf eine abgebrochene, stummelhafte Röhre eines *Paragymnomerus spiricornis* SPIN.—Nestes.

ich auch die hineinfliegende *Anthophora* fotographiert (Fig. 1). Nachdem ich die Wandpartie göffnet hatte, gelang es mir auch, die *Paragymnomerus*-Brutwiegen zu finden, die in einen gemeinsam benützten Hauptgang mündeten. Mit der Benützung der fremden Baute hat sicht die eingewurzelte, herkömmliche Bauart der *Anthophora* gründlich umgestaltet. Sie baute die Röhre ihres Vorbaues anfangs nach oben, baute ausserdem das Gefüge fester, indem sie die Lehmklümpchen dicht nebeneinanderkittete, dann wurde die Röhre allmählich umgebogen und zuletzt gewohnheitsgemäss nach unten herabhängend vollendet. Die Basis musste fester gestaltet werden, um den hinabhängenden Teil halten zu können. Es liegt die Vermutung nahe, dass die *Anthophora* bereits beim Bau des aufwärtsragenden Teiles wissen dürfte, dass dieser Teil fester gebaut werden muss. Hätte sich die *Anthophora* nicht den Gegebenheiten der *Paragymnomerus*-Röhre anpassen können, so würde sie ihr regelrechtes Nest an irgendeiner anderen Stelle der Lösswand errichtet haben. Ein andere *Anthophora* fand sein Schmarotzer: *Trichodes apiarius* L. *(Cleridae)* in seinem Nest als sie nach Nahrungsaufnahme zurückkehrte. Ein solches Zusammentreffen dürfte sich im Leben bereits vorhergehender Generationen von *Anthophora*-Arten ereignet haben, weil das von mir beobachtete *Anthophora*-Exemplar das Feind ohne Verzug zu entfernen begann (Fig. 3).

Ein Beispiel für die Anpassungsfähigkeit stellt auch der folgende Versuch dar: *Sceliphron destillatorium* ILLIG. baut ihr Nest aus Lehmklümpchen nebeneinander in den vor Regen geschützten Spalten und Rissen der Lösswand. Ich möchte hier nicht auf Einzelheiten eingehen und beschränke nicht auf die Bekanntgabe eines Versuchsergebnisses. — Ein Weibchen entfernte sich, nachdem es in dem eben verfertigten Nest die erste Spinne untergebracht und auch ein Ei darauf gelegt hat. Nun habe ich aus einem anderen Nest vier weitere Spinnen in das Nest gesetzt, so dass die zurückkehrende Wespe nur mehr eine Spinne in das Nest zu pressen vermochte. Als sie nochmals erschien, brachte sie nicht mehr eine Spinne mit sich, sondern ein Lehmklümpchen, mit dem sie das Nest verschloss. Anstatt sechs Spinnen brachte sie also nur zwei.

III. Da ich mich mit der Beobachtung von *Paragymnomerus spiricornis* SPIN.-Art am eingehendsten beschäftigt habe (MÓCZÁR 1960a,b, 1961a, 1962), kann ich im weiteren über die Tätigkeit dieser Art berichten.

Um meinen speziellen Zielsetzungen gerecht zu werden, habe ich auf der Lösswand in Tihany eine Reihe von Tieren mit täglich geänderten Lackfarben und ihre Röhren mit Flaggen bezeichnet, die kleine Nummer trugen, in der Absicht, mehr Einzelheiten in Erfahrung zu bringen. Die Tiere wurden im abgekühlten Zustand bezeichnet und es stellte sich heraus, dass sie auf diese Weise ihre Reflexhandlungen später ungehindert fortsetzen. Eine Betäubung mit Aether ist nicht zu empfehlen, denn dann flüchten die Tiere zumeist und kommen an demselben Tage nur vereinzelt zurück. Im Laufe meiner Beobachtungen gelangte ich unter anderem in den Besitz der folgenden konkreten Daten:

Zwecks Nahrungsaufnahme entfernten sich die Tiere täglich 2—3-mal, durchschnittlich je 62 Minuten lang — ausnahmsweise 2 oder gar 20 Tage lang — aufgesucht, d. h. weiter ausgebaut. In rund jeder 5 Minute entfernten sie sich, um Wasser zu holen und verbrachten damit eine Minute. Mit dem herbeigeschafften Wasser wurden 5 Lehmklümpchen verfertigt, ein Lehmklümpchen innerhalb von 23 Sekunden. Auffallend ist, dass die Wespe die feuchten

Lehmklümpchen nicht dicht nebeneinander setzt, sondern immer kleine Zwischenräume frei lässt. Dadurch können die Klümpchen schneller trocknen. Später werden dann auch die Lücken durch weitere Lehmklümpchen ausgefüllt. In 6 Stunden und 40 Minuten wurde ein Gang von 63 mm Länge fertiggestellt; 30 mm davon entfielen auf den Vorbau. Das Material der später ausgescharrten Zellen wurde teils zur Erhöhung der Röhre, teils zur Glättung des Ganges verwendet und der Rest mit einem kurzen Rundflung weggeschafft. Eine Zelle wurde durchschnittlich in zwei Stunden fertiggestellt. In die Zellen wurden durchschnittlich je 7 Afterraupen getragen. Aus dem Ei schlüpfte binnen 3—6 Tagen die Larve, die sich in 7—12 Tagen zu einer graugefärbten, ausgewachsenen Larve mit glänzend straffer Haut entwickelte. Nach 1—2 Tagen begann die vollentwickelte Larve ihren Kokon zu spinnen, der in etwa 9 Tagen vollendet war. Nach weiteren 11 Tagen verfärbte sich die Larve gelblich und ihr Leib schrumpfte ein wenig zusammen, verpuppte sich im April des folgenden Jahres und nach 2,5—3 Wochen schlüpfte das Männchen, im Juli das Weibchen aus. Somit umfasst die Gesamtentwicklungsdauer 10 Monate. Die Weibchen haben eine Lebensdauer von etwa anderthalb Monaten; die betätigen sich durchschnittlich bis Ende Juli.

Zur Veranschaulichung der Handlungen der Wespe haben IWATA (1942) und TSUNEKI (1957) eine Formel ausgearbeitet, in der die selbständigen Handlungseinheiten mit grossen Anfangsbuchstaben gezeichnet werden. Aufgrund dieser teilweise modifizierten Methode habe ich in der Tätigkeit von *Paragymnomerus* zwei Gruppen unterschieden, und zwar die der Selbsterhaltung und die der Arterhaltung.

Die Selbsterhaltung ist durch folgende Einzelhandlungen gekennzeichnet: Warten, Nahrungsaufnahme und Verteidigung. Die Artenhaltungstätigkeit dagegen besteht aus: Befruchtung, Suche nach einem geeigneten Nistplatz, Nestbau, Eiablage, Herbeischaffung des Futters, Schliessung des Nestes. Die angeführten Handlungsweisen lassen sich natürlich weiter unterteilen. Das sei an einem Beispiel veranschaulicht. Der Vorgang des Nestbaues umfasst folgende Handlungen: Scharren, Gangbau, Errichtung des Vorbaues (der Röhre); dem Scharren geht wiederum das Kneten des Lehmklümpchens und seine Herbeischaffung voran. Das Wesentliche dabei ist der Umstand, dass die Wespe diese Handlungseinheiten hintereinander durchführt und dass die eine Tätigkeit die nachfolgende sozusagen induziert. Das Verhalten der Wespe gestaltet sich so in einer Reihenfolge, in der eine Handlung kettengliedartig der vorangehenden folgt. Die neue Tätigkeit wird also durch einen Reiz ausgelöst, der aus der Gesamtheit der Reize der vorhergehenden Tätigkeiten, der ererbten Reflexe entsteht, in geringerem oder höherem Masse aber auch von der Umgebung beeinflusst wird. Lange Zeit fand ich keine Erklärung dafür, warum die Wespe ein eben ausgegrabenes Loch wieder zustopft, anstatt dieses für den eigenen Gebrauch weiter zu vertiefen, oder warum das Suchen nach dem Nistplatz einen Zeitraum beansprucht, der von einigen Stunden bis zu 2 Tagen dauert. All dies hängt mit den momentanen ökologischen Reizen und Wirkungen zusammen.

Bezüglich der Frage, ob äussere Umstände die Handlungsreihe der Wespe zu stören vermagen und wie sie sich dazu verhält, liefern ausser dem hinsichtlich der über *Anthophora* und *Sceliphron* mitgeteilten die folgenden Beobachtungen Aufschluss. (Dieser Versuch beantwortet übrigens teilweise auch Punkt

4 und 5 der Fragengruppe III.) *Paragymnomerus spiricornis* baut an der Tihanyer Lösswand dicht beieinander seine Nester. Es interessierte uns, wie sich die Wespe verhält, wenn unter natürlichen Verhältnissen der Regen einen Teil der Röhren durchnässt und dadurch die Eingangsöffnung verstopft. Versucht sie ihre eigene zu öffnen was doch die Einschaltung einer ganz anderen Handlungsreihe erfordern würde. — Oder dringt sie eventuell in ein anderes Nest hinein? Und welche Tätigkeitsreihe beginnt sie dort? Um dies zu ergründen, habe ich die Röhre der Wespe, die vorher schon dreimal Nahrungsraupen eingetragen hat, in ihrer Abwesenheit zunächst mit Watte und später mit einem Lehmkügelchen verstopft. Die Einzelheiten dieser Prozedur habe ich bereits an anderer Stelle erörtert und will deshalb hier nur das Endergebnis schildern, nämlich dass das Tier, solange die Öffnung nur mit einem Wattebausch verstopft war, anderthalb Stunden lang die verschiedensten Handlungsreihen be-

Fig. 2. *Paragymnomerus spiricornis* SPIN. fing an ein neues Nest zu scharren.

gann: bald fing es an ein neues Nest zu scharren (Fig. 2), bald flog es fort. Sobald aber das Loch mit Lehm verstopft war, stellte die Wespe das weitere Suchen ein und verschwand in einer benachbarten Röhre. Sie begab sich also endgültig in ein anderes, ihr bis dahin fremdes Nest, wo sie — nach längerem Verweilen im dessen Innere — zunächst die Röhre zu errichten begann (richtiger gesagt scharrte sie zuerst Brutwiegen in dem Gang, um dann mit dem erhaltenen Material die Röhre zu bauen) und nicht Nahrungsraupen holte, wie sie es bei ihrem vorigen Nest getan hatte. Hier würde also einwandfrei bewiesen, dass das Tier in ein anderes, in ein fremdes Nest eindrang und dort seine Tätigkeit fortsetzte — allerdings nicht die, in der sie durch äussere Umstände unterbrochen worden war, sondern jene Handlungsreihe, die sich aus dem Zustande des neuen Nestes ergab. Leider hatte ich wegen der bereits fortgeschrittenen Zeit keine Gelegenheit mehr, ihre weiteren Handlungen — ganz bis zur Nestschliessung mitsamt der Larvenbeförderung — zu verfolgen. Ich habe aber der öfteren beobachtet, dass *Paragymnomerus* auch das andere Mal in fremde Nester eindrang. Mehr als einmal sah ich, wie *Odynerus* Individuen vor dem einen oder anderen Röhreneingang stritten, und einander fortjagen

Fig. 3. *Anthophora parietina* entfernt seinen Schmarotzer: *Trichodes apiarius* L. aus seinem Nest.

wollten. Offensichtlich ereignet sich diese Erscheinung nur in dem Falle, wenn ein *Paragymnomerus* aus irgendeinem Grunde in eine andere, bewohnte Brutwiege eindringt und dort dem Eigentümer begegnet. Auch konnte ich beobachten, wie es einem *Paragymnomerus* mislang, beim Heimschaffen der Futterraupe auf den ersten Anhieb in ihre eigene Röhre hinein zu fliegen, und mitsamt der Beute herunterrollte und mit seinem schweren Last erneut einen Versuch unternahm, flog dann auch auf die Röhre eines anderen Nestes, drang in die eine fremde Röhre ein, aus der er aber flugs wieder herauskam, die für seine Nachkommenschaft bestimmte Raupe, mit sich schleppend und dann nach einigen orientierenden Rundflügen auf dem Rande des eigenen Röhrchens aufsitzend, wieder nachhause fand.

Es ist offensichtlich, dass *Paragymnomerus* — und wahrscheinlich auch andere gruppenweise lebende Wespen und Wildbienen — sich am Weiterbau und an der Weiterentwicklung eines nachbarlichen, fremden Nestes zu beteiligen vermögen. Das Eindringen in fremde Nester hatte bereits 1964 auch LIN als hochwichtige — natürlich noch primitive — Voraussetzung zum Übergang von der solitären Lebensweise zum Gemeinschaftsleben bezeichnet. Dies ist allerdings noch weit entfernt von einem kontinuierlichen Füttern der Nachkommen bzw. von der simultanen Anwesenheit zweier Generationen: von Eltern und Jungen, die bereits einem wirklichen typischen Gemeinschaftsleben entspricht.

V. Auf den letzten Punkt unserer Fragenstellung, nämlich auf Punkt IV., auf die Frage, ob die Erforschung des Verhaltens der Insekten über die theoretischen Ergebnisse hinaus auch praktische Beziehungen aufweist, erlaube ich mir mit einer kurzen Zusammenfassung unserer Befunde bei der Luzerne-Forschungen antworten. Die wichtige Rolle der Luzerne die sie als Futterpflanze bekleidet ist allbekannt. Die Grundlage hierfür ist ein sicherer Samenertrag, maximale Insektenbestäubung der den speziellen Anbaugebieten entsprechenden Luzernebestände und — nicht zuletzt die Bekämpfung der Schädlinge. Dies hat in den 50-er Jahren die Aufmerksamkeit in aller Welt auf die *Apoiden* gelenkt und hat mich veranlasst, zur Lösung der ökologisch-ethologischen Probleme dieser Insekten auf Ersuchen der ungarischen Luzerneveredler eine Landesaufnahme durchzuführen. Im Laufe von 3 Jahren haben wir 9200 *Apoiden* eingesammelt, auf 26 000 m² Fläche 33 000 Exemplare registriert und von 16 000 Blütenbesuchsdaten innerhalb 1500 Minuten eine Antwort auf folgende Fragen gesucht:

1. Welche *Apoiden*-Arten leben auf unseren Luzernefeldern?
2. In welcher Abundanz und Dominant-Verteilung kommen sie während der Blütezeit vor?
3. Welchen Wert weist ihre Blütenbesuchs-, Nektar- und Pollensammeltätigkeit auf hinsichtlich Blütenöffnung und Bestäubung?

Die Aufmessung führte zu unerwarteten Ergebnissen. Zunächst habe ich die Dominanz Verteilung der die Luzernefelder der verschiedenen Anbaugebiete aufsuchenden Wildbienenarten (MÓCZÁR 1961d) ferner die Abundanz der einzelnen Arten festgestellt (MÓCZÁR 1961b). Anschliessend ermittelte ich die Aktivität der wichtigsten Arten, d. h. den Prozentsatz der geöffneten unter den 100 besuchten Blüten (MÓCZÁR 1959). Auf Grund dieser Beobachtungen konnte auch die Anzahl der Blüten festgestellt werden die Wildbienen pro Minute aufbrechen.

Alle diese genauen Daten waren nötig, denn es ist keineswegs indifferent, ob die, den riesigen Samenertrag sichernde, maximale Bestäubungstätigkeit von den nur in niedriger Individuenzahl vorhandenen, über eine ausgezeichnete Aktivität verfügenden, d. h. Blüten besuchenden und öffnenden, oder aber von Pupulationen der individuenreichsten, dominanten und noch befriedigend aktiven Arten mit hohem Öffnungsprozentsatz erwartet werden kann.

Um ein richtiges Bild über die wahre Tätigkeit der Wildbienen zu verschaffen muss einerseits die Zahl der geöffneten Blüten mit den Minuten der Beobachtungszeit dividiert und andererseits der Quotient mit der Individuendichte der entsprechenden Wildbienenpopulation multipliziert werden. Auf diese Weise ist ein klares Bild über die Bestäubung geleistete Arbeit für sämtliche Arten erhältlich (Fig. 4).

Fig. 4. *Melitta leporina* Pz. leistet fast die erfolgreichste Arbeit bei der Bestäubung der Luzernen-Blüten. (Alle Aufnahmen von Verfasser).

In den verschiedenen zoogeographischen Landschaftseinheiten Ungarns haben wir naturgemäss unterschiedlich zusammengesetzte Wildbienenbevölkerungen vorgefunden. Anderen Ökologischen Bedingungen entsprechen andere Wildbienenfaunen. Als Ergebnis unserer Forschungen ist es uns aber gelungen, jene Stellen festzusetzen, wo die Wildbienen eine optimale Bestäubungsaktivität entfalten und wo die von der Luzerneveredlern entwickelten, prominenten Luzernesorten hochaktive Bestäuber vorfinden, so dass auch der Samenertrag ein maximaler werden kann. In praktischer Hinsicht haben sich meine wichtigsten ökologisch-zönologischen und ethologischen Forschungen auch auf die Nistverhältnisse der wichtigsten Wildbienenarten erstreckt und sogar ihre künstliche Ansiedlung auf Luzernefeldern habe ich erfolgreich versucht.

Aus den Angeführten geht deutlich hervor, wie kompliziert sich die Tätigkeit der Wespen und Wildbienen gestaltet und dass sie nicht eine unauflösbare, geschlossene Einheit einer einzigen Handlungsserie darstellt, sondern dass er sich um eine dem Einfluss von Umweltfaktoren unterworfene, diesen sich nicht selten anpassende, elastisch veränderliche, instinktive Handlungsreihe handelt. Die *Aculeaten* reagieren auf äussere Einwirkungen träger, je näher der Termin der Eiablage rückt. Das erste Kettenglied des Überganges vom solitären zum Gemeinschaftsleben dürfte das Eindringen in ein fremdes Nest und die dort fortgesetzte Brutwiegenbereitigung gewesen sein.

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ECOLOGY OF THE HALOPHILIC VEGETATION OF THE PANNONICUM VII. ZONATION STUDY ALONG THE BEGA-BACKWATERS IN THE VOIVODINA (YUGOSLAVIA)

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In the cours of studying the halophilic vegetation of the Pannonicum, there was provided for us an opportunity, as well, to investigate the halophilic vegetation of the Bega-region in Bánát. In the progressively drying bed, resp. in the vicinity of backwater reaches detached in a natural way or cut off by regulation, there have been produced soils of alkali character in various degrees, resp. various biogeocoenoses. These plant communities of a soil becoming alkali in various degrees and reflecting different hydrographic conditions are forming a variegated zonation system.

The aim of these investigations is to clear up the connections between the vegetation cover of the single zones and their biotic and abiotic ecological factors.

For carrying out our aims, the Bega-backwater reaches in the vicinity of Zrenjanin have proved to be suitable.

The floristic-phytocoenologic elaboration of these areas with summarizing character had already taken place some decades ago in the same way as that of the halophilic plant cover of other areas in the Voivodina, Bácska, and Bánát (SLAVONIĆ, 1939; 1948). In our investigations we want to take part in carrying out the programme of the Hungarian—Yugoslav research co-operation by clearing up further synecological detail problems.

We have got a basis for the zonation conditions of halophilic communities in Yugoslavia by SLAVNIĆ's investigations (1939) who added also some short remarks to his observations for characterizing the soil.

Discussion of the results of investigations

I. Observations carried out in the area of Arda, West of Zrenjanin.

The Bega-backwater lying here is surrounded by a spacious solonetz heath pasture with artemisia. Following its vegetation of solonetz soil arranged mosaic-like, towards the backwater, certain zonality is to be noticed, as well, as a result of the relief-differences in a terrace-like pattern.

Zone 1 was missing here. Zone 2 stands out of the solonetz level, with a chernozem surface soil and in its lower layers with sodic solonetz. Its community is: *Achilleo-Festucetum pseudovinae limonietosum* (STAVNIĆ 48), BODROGK. 59. It is showing a transition towards the vegetation of a steppe with artemisia. On the basis of tabulated recordings it could be ascertained that the *Festuca pseudovina* of dominating role generally forms 40—50 per cent of the total cover of 75—80 percentage. The other species — prevailingly the glycophilic ones occurring in 5—10 per cent — take part in the community due to the upper 20 cm alkali-free ground level. Thus the *Achillea collina, Gypsophila muralis, Plantago lanceolata,* as well as the *Kochia prostrata* showing a great ecological adaptability and occurring habitually in the southern areas of the Pannonicum (SLAVNIĆ 1939).

The appearance of some ephemerous *Trifolium* species is similarly connected with the alkali-free upper ground level, like that of *T. striatum, T. retusum, T. campestre,* as well as *Scleranthus annuus.* They are showing the scanty in rainfall in the spring aspect of the year of investigation with the low individual growth and the conditions of dominance.

The appearance of *Limonium gmelini* — here in the same way as in other regions beyond the Tisza — is referring to the presence of deeper lying solonetz layers. The laboratory data of the soil profile unearthed in that zone give some proof here, too. According to them, below the calcium carbonate and alkali-free A-level there follow meadow solonetz layers of solonchak character with 0.25 per cent maximum salt content (Table 1).

Zone 3 is *Artemisio-Festucetum pseudovinae achilleetosum.* Its species combination is showing a transition towards the grass cover of the previous zone. Owing to the considerably more unfavourable habitat conditions, the vegetation cover is not more than 40 per cent. There prevailed here, too, the *Festuca pseudovina* with a dominance of 10—15 per cent. A considerable part is played by the character species: *Artemisia maritima* ssp. *monogyna,* etc. As a result of favourable heat, resp. light conditions, it can be found in state of flowering already at the end of May. The other is *Limonium gmelini* that sporadically achieved even the values of 10 per cent cover.

Its differential species is *Achillea collina;* its dominance values have anyway achieved but rarely the 5 per cent. On the other hand, the appearance of *Hordeum hystrix* in spots may be considered as a consequence of an increased grazing.

The qualitative and quantitative relations of the ephemerous species of the lower grass layer are showing some connection with several changes manifested mainly in the domain of hydrographic conditions. The small stalks of weed of *Sedum rubrum,* together with the remains of *Myosurus minimus,* lead us to conclude more humid habitat conditions than the average ones are. At present, however, they could be found only exceptionally. There is more important the rather significant expansion of *Matricaria chamomilla* var. *salina* and *Polygonum aviculare* that having germinated as a result of the plenty of rainfall in the latter weeks, have overgrown the barren spots.

The barren spots, seemingly missing any plant cover, have proved in this way not to be without any vegetation. In the aspect of early spring, *Poa bulbosa* had filled here a part. As a result of drought, however, its parts

being overground already in May have withered. Its quantitative conditions can be concluded from the amount of its bulbils piercing through the soil. The formation of the increasedly xerothermic conditions may be a concequence of the solonetz layers being near to the surface.

The relief of zone 3 was anyway lying 20—40 cm or so deeper, from which zone 1 stood out like an island or a kind of micro-terraces.

And it had also a corresponding soil structure. As — on the basis of data known by us so far — we can draw a consequence from the species components of the grass cover, we have got here a rough meadow solonetz soil with moderate steppes and a 5—8 cm thick alkalized A-level, and with a columned B_1-level without any major salt accumulation. That is the explanation of the formation of a sub-association of glycophilic character, the 0.10—0.12 per cent total salt content being endurable also for the glycophilic species of xerophilic character. A salt accumulation in the B_2-level could be demonstrated below 40 cm (Table 1).

Table 1. Results of the comparative laboratory investigations of the soil profiles of vegetation zones 2 and 3

Soil depth in cm	Arany's fixity	Humus	Calcium carbonate	Total salt	Sodic alkalinity
		per cent			
Achilleo-Festucetum pseudovinae limonietosum					
0— 5	62	4.82	0	0	0
5—10	54	3.33	0	0.05	0
10—20	49	2.24	0	0.09	0
20—40	61	2.05	4.36	0.22	0.09
40—60	72	1.97	5.64	0.27	0.11
60—80	81	1.61	9.14	0.25	0.11
Artemisio-Festucetum pseudovinae achilleetosum					
0— 5	67	2.95	0	0.10	0
5—10	60	2.80	0	0.12	0
10—20	79	2.14	0	0.15	0
20—40	73	2.02	0	0.40	0
40—60	78	1.02	4.44	1.00	0.04
60—80	77	1.49	8.98	1.00	0.04

We obtain a picture about the physical structure of soil by the percentage of fraction analysis of its unearthed profile (Fig. 1B). Here is the B_1-level of columnar structure the most fixed, the physical sand is 40 per cent or so, and both clay fractions have shown a value of 60 per cent.

Zone 4 is, as a matter of fact, an extrazonal appearance of the saline speargrass meadow. In the depressions of the artemisia steppe eroded by currents, owing to the favourable hydrographic conditions high above the meadow-zone, in a meadow soil that is saline in the depth, there was predominant the sub-association *Limonium gmelini* of *Agrosti-Alopecuretum*, indicating a deeper lying solonetz layer. The winding water courses and

their direction were delimited sharply from the adjacent grassy steppe not only by the different plant cover but also by the light green hue of *Agrostis alba*.

Its species combinations were forming a double grass layer, differing hardly from the species associations of the marshlands of the meadow solonetz fens.

In the same zone, in the enlarging stagnant-water sectors of the streamlets, the speargrass meadows are replaced by the spots of alkali silt associations. The ephemerous species components of this *Pholiuro-Plantaginetum tenuiflorae* were showing several transitions towards the marshy meadows, and *Ranunculus lateriflorus* presented itself to be facies-forming: with regard to the arid early summer conditions of the investigated year, in fragments — *Myosurus minimus* subass. (Slavnić 48) Bodrogk. 65.

Zone 5 is lying at the rim of the bed of the Bega-backwater and is a hygrophilic species combination of *Agrosti-Alopecuretum*. As a result of an unreasonable utilization in the course of pasturing some species tolerating the treading became predominant, thus the facies of association *Agrosti-Alopecuretum trifolietosum fragiferi* (Ubr. 48) Bodrogk. 65. *Medicago lupulina* that could form in that zone sporadically even a 15—20 per cent cover. This was supported by the considerably lower dominance value of *Lotus corniculatus, Trifolium repens, T. fragiferum*, as well.

On smaller mounds, from the growth of *Festuca pseudovina, Lolium perenne, Salvia nemorosa, Thlaspi arvense* we could conclude xero-mezophilic habitat conditions exposed to being stamped.

The *Limonium gmelini* occurring thread by thread has proved the presence of lower meadow solonetz layers.

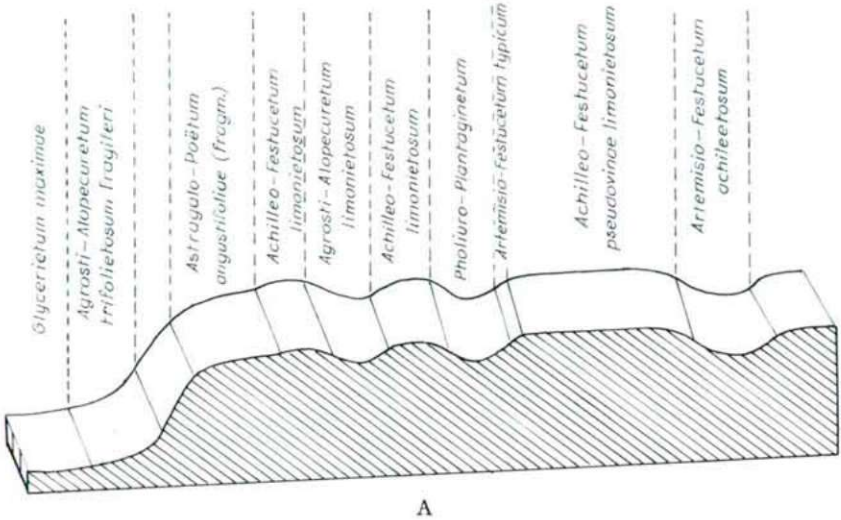
The region of zone lying in the vicinity of the backwater has shown already a transitory character. As a result of higher humidity, there occurred the *Bolboschoenus maritimus* as a differential species, forming a sub-association of *Agrosti-Alopecuretum bolboschoenetosum* that approaches the sub-association *Bolboschoenetum maritimi agrostetosum* Bodrogk. 62, of similarly transitory charcter.

Zone 6, that is simultaneously the zone of deepest relief of the area, the *Glycerietum maximae* Hueck 31, filled up the largest part of the Bega-backwater in the year of investigation, as well. The total cover of its stand did not exceed 40 per cent, here either, of which *Glyceria* was 10—15 per cent, *Typha angustifolia* 10 per cent. Owing to the water regularization, the species *Agrostion*, mainly *Symphytum officinale, Lythrum virgatum, Lycopus exaltatus*, etc. prevail more and more (Fig. 1A).

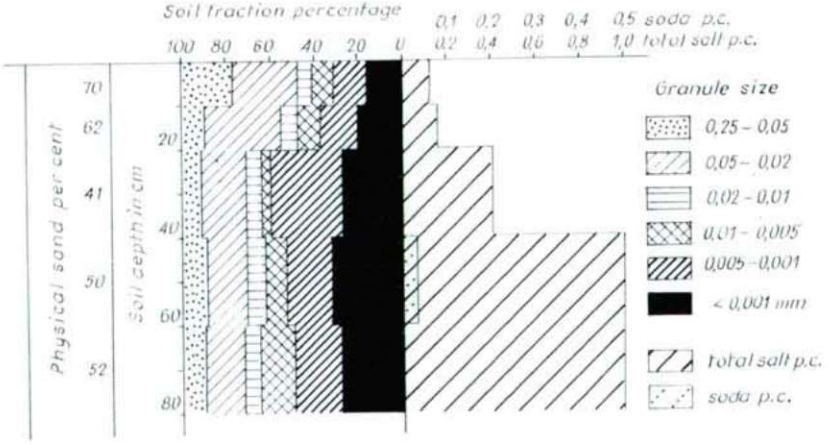
Formation of artificial micro-zonation systems

The micro-zones that have developed for twenty-four years on the crater-slopes of the shell-holes from World War II in the south-western area of the „alkali meadow of Aradác", have proved to be highly suitable for investigating the vegetation cover of the zone system produced as a result of the ground and relief differences. They were deep enough even after two and half decades for showing subsoil water on their bottoms.

The hole marked with 1 has taken place in the soil of a withering *Agrosti-Alopecuretum* meadow. Its siltation was rather slow and that crater is the deepest one even to-day. The soil that had been blown up resulted in a rising ground at the rim of bomb-crater. On that a secondary *Achilleo-Festucetum pseudovinae* typicum was produced.



A



B

Fig. 1. Zonationsystem in the area at Arda (A). Soil-physical and chemical conditions of the *Achilleetosum* profile of *Artemisio-Festucetum pseudovinae* (B).

80 cm deep from the rim of crater, on the hole-side, similarly to the bank-zone of the Bega-backwater, the *Carex vulpina* facies of *Agrosti-Alopecuretum* may be found, with *Eleocharis palustris*, showing that also the lower layers are salt-free.

On the crater-slope, in a depth of 2.5 m, a zone soaked by the subsoil water, the fragmentary species combinations of the *Polygono-Bolboschoenetum* described from the Tisza-basin can be recognized, with 60 per cent dominance; among them *Rorippa amphibia Glyceria fluitans.*

In the deepest zone of the crater whose diameter is 2 m or so (!), where the subsoil water could be estimated about 15—20 cm deep, *Scirpo-Phragmitetum typhetosum angustifoliae* became dominant; in its species combinations *Alisma plantago-aquatica* was of higher dominance percentage (Fig. 2A).

The hole-group marked with 2, on the other hand, took place in the meadow solonetz soil of *Artemisio-Festucetum pseudovinae.* As a result of the precipitation, resp. soil water that have exerted their effect for more than two decades, the bomb-craters became silted in a shorter time due to the soil liquefaction by the *Na* ions. These craters were therefore hardly 50—60 cm deep in the time of investigation.

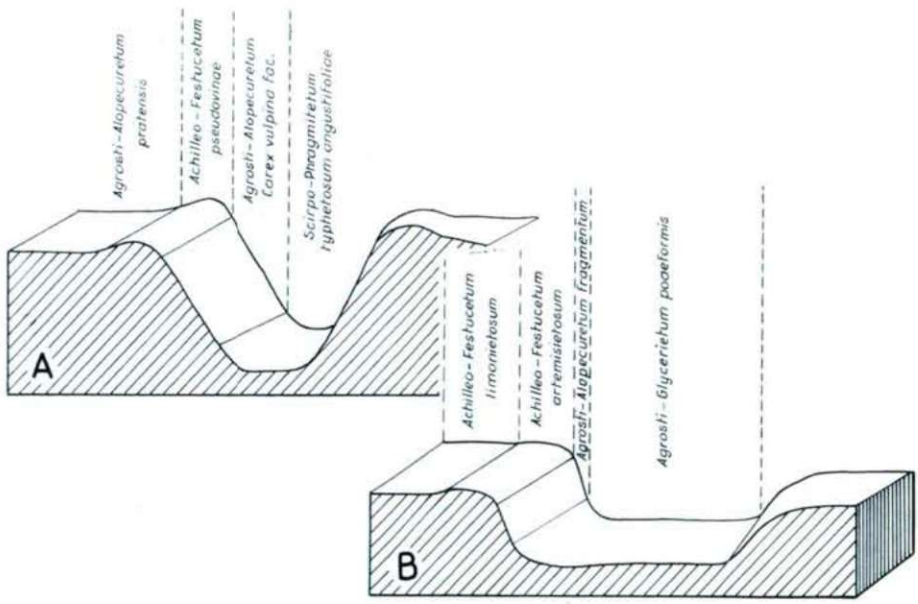


Fig. 2. Micro-zonation conditions of the bomb-craters in the meadow at Aradác, sunk in meadow (A) and solonetz soils (B).

Their zonation is the sub-ass. *Achilleo-Festucetum Limonium,* followed on the rim of the crater by the sub-ass. *Artemisia monogyna.* In the deeper-lying micro-zone *Agrosti-Alopecuretum,* on the bottom *Agrosti-Glycerietum, Bolboschoenetum,* and on the bottom of other craters *Glycerietum maximae* became dominant, with *Typha angustifolia* (Fig. 2B).

Zonation conditions of the fen at Baglyas

In this part of the Bega-backwater a deep-lying flat fen was formed in the course of the siltation. Its hydrographic conditions were much more favourable than those of the area investigated previously. For the vegetation cover, during the whole season of growth, a suitable water supply is available, in that way the plant associations of the single zones became considerably richer in species.

As the preconditions of salt accumulation are by no means assured in such a degree that a halophilous plant cover could have formed, the areas forming the higher zones have got under agricultural cultivation. Thus, in the original state, two zones could be separated.

1) *Agrosti-Alopecuretum gratioletosum (officinalis)* in the higher zone of the marshland. Its differential species are: *Gratiola officinalis, Oenanthe silaifolia, Rorippa austriaca.*

The association is of double level. In its lower level, *Trifolium repens, Lysimachia nummularia, Potentilla reptans* are of high dominance; its moss layer is formed by *Drepanocladus aduncus.*

The association, concerning its composition, is very similar to the vegetation in some inundation areas of the Tisza in Hungary (BODROGKÖZY, 1962). Thus some hybridization could be observed between the species combinations of the weakly alkali marshlands and the marshlands in the inundation areas.

2) *Agrosti-Beckmannietum gratioletosum (officinalis)* (nom. nov.). The fen at Baglyas is a zone of lower relief, inundated by soil water the most intensively. In its species combinations the glyco-hygrophilic species are dominant, first of all *Gratiola officinalis,* the name giver of the sub-association. *Oenanthe silaifolia, Euphorbia palustris, Juncus atratus,* that are forming a considerable part of cover, may be considered as differential species. They

Table 2. *Agrosti-Beckmannietum agrostetosum*

Soil depth in cm	Arany's fixity	Humus	Calcium carbonata	Total salt	Sodic alkalinity
		p e r c e n t			
0— 10	47	4.41	4.90	0.11	0.03
10— 20	38	1.92	7.36	0.11	0.06
20— 40	61	0.63	7.52	0.25	0.16
40— 60	80	0.33	4.80	0.60	0.07
60— 80	50	0.30	2.40	0.50	0.13
80—100	98	0.41	2.92	0.35	0.13
		Agrosti-Beckmannietum typicum			
0— 10	63	3.30	2.08	0.10	0
10— 20	72	2.82	1.88	0.10	0
20— 40	58	2.14	1.70	0.11	0
40— 60	68	2.10	4.52	0.14	0
60— 80	66	1.36	14.10	0.13	0

are usually missing from the solonetz fens, emphasizing here, too, the transitory character towards the phytocoenoses of the inundation areas and other marshlands. In its moss layer, similarly *Drepanocladus aduncus* was forming uninterrupted stands.

In regard of the dominance conditions, we may find sporadically even total covers of 60—70 per cent. There are dominant *Beckmannia eruciformis* forming the upper grass layer, and *Agrostis alba* forming the lower grass layer. *Gratiola* and *Oenanthe silaifolia* could, anyway, achieve a participation of 30—40 per cent of the total cover of 60—70 per cent. That can be connected mainly with the favourable nutrient and hydrographic conditions of the meadow soil that is saline in the depth (Table 2).

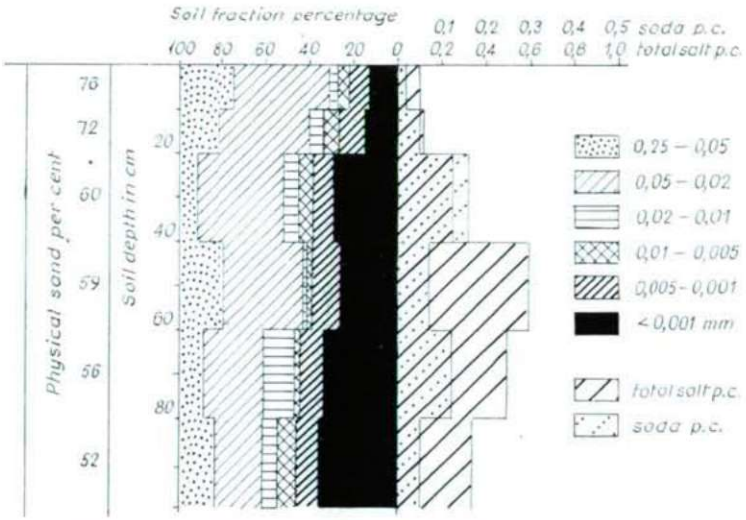


Fig. 3. Results of investigation of the soil profile of *Agrosti-Beckmannietum agrostetosum*.

Zonation conditions in the area of Muzslya

About 2 km south-west of the village, the parallel and later zigzagged courses of the Bega-backwaters lying in east-west direction cam be found. Starting from the villages, we have investigated the first and second backwaters and their vicinity.

Besides the ground and relief differences, there played a considerable part in respect of the formation of the plant cover of the single zones also the zoogene effect brought about by the vicinity of the settlement. There have sporadically appeared the signs of becoming barren as a result of the intensive pasturage and treading. Between the two backwaters, the area is not suitable for being cultivated agriculturally, in this

way, the grass associations of the single zones, the vegetation cover producted as a result of the complex effect of biotic and abiotic factors, have appeared as suitable for phytocoenological investigations.

Zone 1 was missing here, too. Zone 2 is the *Poa bulbosa* facies of *Achilleo-Festucetum artemisietosum* BODROGK. 65. On its strongly eroded berms the total cover of vegetation is 30—40 per cent. The participation of *Artemisia maritima* ssp. *monogyna* is sporadically the highest, in other places becoming more barren the participation of *Poa bulbosa* gets a leading part at the expense of *Festuca pseudovina*. In the latter case, some spots seemed to be fully barren because the *Poa bulbosa* withered except its underground organs. The berm-side and eroded depressions were, however, covered by *Camphorosmetum annuae* (RAPAICS 16) SOÓ 33.

Table 3. *Achilleo-Festucetum pseudovinae cynodontetosum*

Soil depth in cm	Arany's fixity	Humus	Calcium carbonate	Total salt	Sodic alkalinity
		per cent			
0— 5	66	3.85	0	0.09	0
5— 10	49	3.22	3.00	0.08	0
10— 20	34	1.13	4.88	0.09	0
20— 40	40	0.46	9.58	0.22	0
40— 60	50	0.35	18.38	0.40	0
60— 80	45	0.30	10.00	0.32	0
80—100	42	0.20	10.40	0.25	0
		Artemisio-Festucetum pseudovinae camphorosmetosum			
0— 5	48	1.66	0	0.07	0
5— 10	35	1.20	1.70	0.22	0.10
10— 20	49	1.14	3.42	1.50	0.23
20— 40	49	1.35	3.50	4.00	0.31
40— 60	46	0.39	4.96	2.50	0.42
60— 80	45	0.25	19.20	1.50	0.40
80—100	47	0.20	20.76	0.38	0.32
		Camphorosmetum annuae Puccinellia facies			
0— 5	46	2.02	3.94	0.22	0.07
5— 10	36	1.06	6.58	0.30	0.24
10— 20	36	0.36	6.84	0.70	0.27
20— 40	40	0.32	5.40	0.90	0.30
40— 60	50	0	16.22	0.40	0.14
60— 80	48	0	16.68	0.20	0.06
80—100	49	0	11.28	0.16	0.06

The low number of species is not only a result of the exaggerated biogenic effect but also the consequence of the chemical composition of soil. The 20 cm thick A-layer was in regard of the total salt content near to have an alkali character, below it being a solonetz B-layer. The presence of soda could not be demonstrated (Table 3).

In some regions of this zone, on island-like arising reliefs, in areas less touched by an arosion, the coenoses of a grass comparatively rich in species, subass *Cynodonti-Poëtum* (RAPAICS 26) Soó 57 *Festuca rupicola* fac. resp. *Achilleo-Festucetum cynodontetosum* developed, producing the properly first zone. Their total cover achieved 80 per cent, in 60 per cent of which *Festuca rupicola* took part. From their species combinations, the deep rooting halophytons were entirely missing. In that way, their meadow chernozem soil is free from getting a solonetz character (Table 3).

3) This zone, formed terrace-like and lying 30—40 cm lower than the former one, gave the area already a solonetz character. The A-layer of its soil profile is hardly 5 cm, in its modestely steppe-like, rough meadow soil, as a result of its calcium carbonate and soda content near the surface, an artemisi-steppe variety, approaching the barren ground, of *Artemisio-Festucetum pseudovinae camphorosmetosum* (RAPAICS 27) SLAVNIĆ 48 developed. From among the zones investigated here this was the most extensive.

Owing to the damaging influence of the considerable total salt, resp. alkali values near to the soil surface, supported by the increased biogenic effect, a closed grass cover of the *Festuca* stand could not develop, and at the end of May it got already an open character. In the 45 per cent total cover *Festuca pseudovina* participated only with 5, *Poa bulbosa*, on the other hand, however in a state of rest, participated with 20 per cent. From among the halophilic species, apart from *Camphorosma annua*, threads of *Kochia prostrata*, *Plantago maritima* have shown soil-ecological conditions of solonchak character. *Lepidium ruderale*, *Matricaria chamomilla* var. *salina* of broad ecological adaptability can similarly be observed. At the same time, two characteristic representatives of the artimisia steppes, *Artemisia monogyna* and *Limonium gmelini* could be found only by threads in some parts of this zone.

Zone 4 could be found by approaching the Bega-backwater marked by us with number 1. The solonetz layer, resp. that containing the salt accumulation can already be found on the surface of the eroded relief or in its vicinity. But here are the hydrographic conditions already more favourable and the zone is, therefore, occupied by the *Puccinellia limosa* facies of *Camphorosmetum annuae*. Total cover is between 35—50 p. c., the dominant species being *Puccinellia limosa*. Its dominance conditions, resp. its participation in the total cover are depending upon the degree of pasturage. Its existence is assured salt content did not rise, even in the accumulation layer of the relief unearthed at the end of May, above one per cent. Also the 2 per cent organic material content near the surface is exerting a compensating effect on the soil-ecological conditions of the root zone. There occurs in some loftier regions of this zone, having therefore a leached A-layer, that owing to the increased biogenic effect a degraded steppe was formed, the dominant species of which are: *Hordeum hystrix Carex stenophylla, Cynodon dactylon.*

Zone 5 was occupied, as a consequence of a further lowering of the level by alkali meadows. *Puccinellietum limosae polygonetosum avicularis* was dominant. The *Puccinellia*, for some cause, could not be closed, the barren

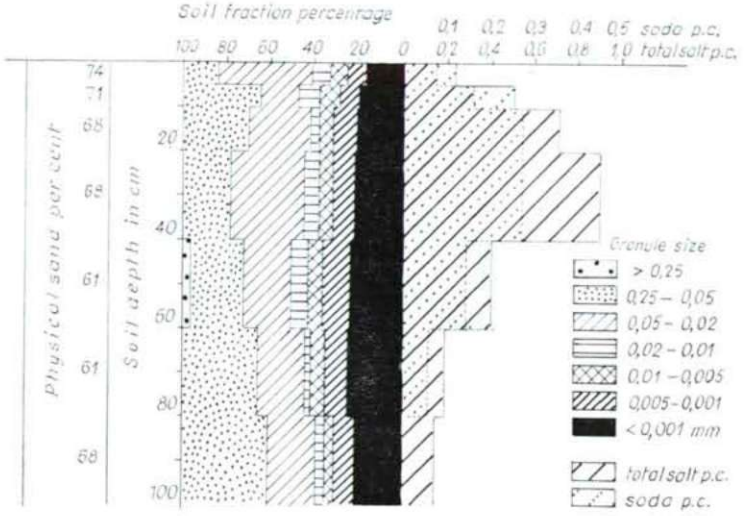


Fig. 4. Results of investigation of the soil profile of *Puccinellietum limosae camphorosmetosum.*

soil spots were therefore occupied by *Polygonum aviculare.* The pushing forward of the ephemerous *Polygonum* may supposedly be explained by the periodic state of being covered by water that is unfavourable for *Puccinellia.* The place of the withdrawing honey grass is occupied, similarly to those observed in other regions of the Pannonicum, in water-free periods.

Zone 6 has formed a narrow strip at the rim of bed of the backwater marked with No. 1. It is a typical alkali silt-association, its ephemerous species combination developed, therefore, in the bank region that became dry after sinking of the surface of water.

On the same tarrace-height, owing to the shorter lasting water-coverage of the bank-line of backwater 2, the coenosis is formed by perennial hygrophilic species. The soil of this zone is less alkalized, thus the *Agrostis alba* sub-association of *Agrosti-Alopecuretum* could develop.

Pholiuro-Plantaginetum tenuiflorae (RAPAICS 27) WENDELBG. 43 *eleocharetosum (uniglumis)* has shown — mainly because of the soil of zone becoming strongly saline — a transition towards the zone above it with *Puccinellia.*

Its soil is meadow solonetz of solonchak charakter in the profile of which calcium carbonate and sodic alkalinity can be demonstrated from the surface. The upper five cm of the A-layer is, anyway, so much eluviated that the total salt content did not rise above the limit of alkalinity (0.11 per cent), in this way also the weakly salt-tolerant hygro-halophilic species could find suitable essential conditions (Table 4).

Zone 7 is in the bed of backwater 1 where water has but a periodical character. After desiccation, the formation of a characteristic silt-plant community became possible. That zone is below the solonetz layer, therefore but a weakly solonchak poured soil is formed in the whole bottom-breadth of the water-bed. Its association is *Heliotropio-Verbenetum supinae* SLAVONIĆ 51,

Table 4. Zone 6. *Pholiuro-Plantaginetum tenuiflorae eleocharetosum (uniglumis)*

Soil depth in cm	Arany's fixity	Humus	Calcium carbonate	Total salt	Sodic alkalinity
		p e r c e n t			
0— 5	42	2.41	3.60	0.11	0.02
5— 10	37	0.99	4.68	0.14	0.11
10— 20	56	1.02	5.09	0.30	0.24
20— 40	59	0.36	5.90	0.50	0.31
40— 60	66	0.26	4.80	0.60	0.21
60— 80	68	0	8.60	0.35	0.19
80—100	58	0	20.08	0.30	0.10

Zone 7. *Bolboschoenetum maritimi agrostetosum*

Soil profile in cm	Arany's fixity	Humus	Calcium carbonate	Total salt	Sodic alkalinity
		p e r c e n t			
0—10	58	4.60	4.80	0.09	0.05
10—20	49	1.76	4.68	0.11	0.15
20—40	86	1.01	3.68	0.38	0.14
40—60	96	0.51	3.76	0.40	0.24
60—80	96	0.28	2.48	0.80	0.24

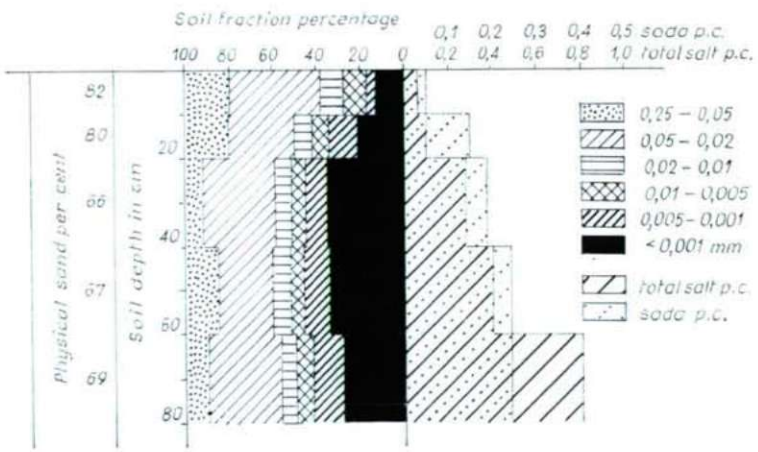


Fig. 5. Soil profile of *Bolboschoenetum maritimi.*

described by SLAVONIĆ from several regions of Voivodina. From among its character species, the *Verbena supina* of Pontic-Mediterranean origin presented itself in large numbers. Apart from it *Chenopodium chenopodioides (= Ch. botryoides)* occurred as a differential species. Presenting itself en

masse, it is in fact predominant in the area. In other regions of the Pannonicum, under similar habitat conditions, it forms sub-associations in other halophilous communities.

In the zone of similar level of Bega-backwater 2, the sporadically appearing stands of *Bolboschoenetum maritimi,* resp. *Scirpo-Phragmitetum* could be observed.

Z o n e 8. The bed-reaches of Bega, lying deeper than the former level, are therefore a water-covered zone in a great part of the vegetation season. Its vegetation is *Batrachio-Ranunculetum polyphylli* Soó 61, one of the associations of *Ruppion maritimae* Br–Bl. 31, characteristic of the alkali waters. We are knowing rather little about its association conditions in connection with the Pannonicum. From the Voivodina it is mantioned by Slavnić (1956).

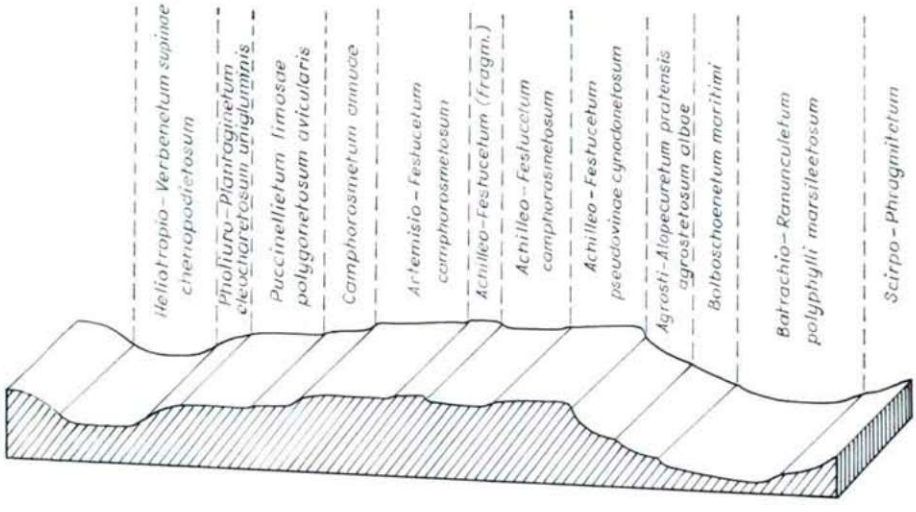


Fig. 6. Result of the increased anthropogenic effect upon the plant communities forming the zonation-system of Bega-backwaters 1 and 2.

In the Bega-backwater marked with 2, there developed a peculiar species combination of its, presenting itself as a differential species of *Marsilea quadrifolia.* Its appearance en masse in some places was an evidence of its favourable life conditions in weakly alkali lakes. It is, as a matter of fact, a plant species of the marshy silt soils but — in case of similarly inundated rice cultures — it endured even a higher water coverage without being damaged.

Elsewhere we could observe the appearance of complex character of its reed-grass vegetations. In this way, *Nymphoidetum pleltatae* (Allorge 22) Oberd. et Müller 60., *Potametum lucentis* Hueck 31, *Oenanthetum aquaticae* Soó 27 can also ba considered as fragments of the reed-grass vegetation sur-

vived from the period of the old high-level backwaters, and they can be found even to-day in the deeper sectors of the backwater in their original association.

About 5 km West of Muzslya, in the area of the backwaters marked with Nos. 5 and 6, we have repeated our zonation investigations for controlling the above ones. Between the two meanders, similarly to the previous ones, an untouched, original grass cover was at our disposal.

The single zones and their vegetations have shown approximately identical connections. The more variegated relief conditions led to a repetition of zones many times.

The highest zone (1) of the ridge between the backwaters was here covered by a rich species association of grass with chernozem soil .It was saved from the danger of being devastated only by its complicated approachability. Its species combinations are entirely missing the halophytic representatives. We cannot speak, therefore, about the lower soil layers becoming more and more solonetz in character.

Its plant stands are in two layers. The upper one was formed by *Poa angustifolia, Agropyron repens,* the lower one by *Astragalus austriacus, Trifolium campestre, T. retusum, Cynodon dactylon* with *Festuca pseudovina.*

Zone 2, the *Achilleo-Festucetum pseudovinae cynodontetosum* has had similarly a species combination without species of halphilic character.

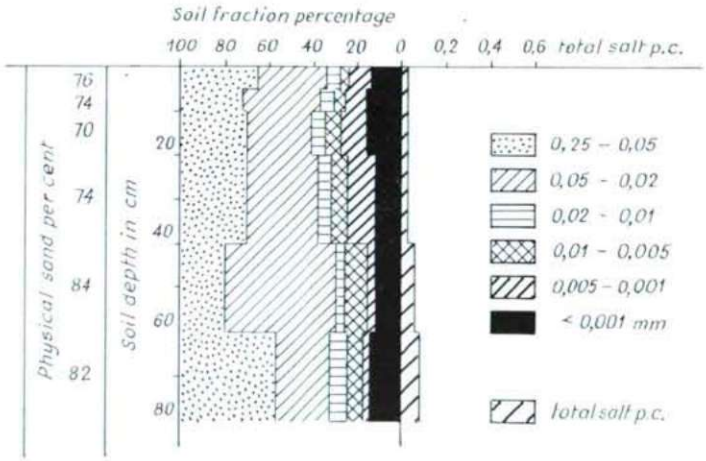


Fig. 7. Soil profile of *Achilleo-Festucetum pseudovinae cynodontetosum.*

Its unearthed soil profile is fully soda-free, and a major salt content could not be demonstrated in layer B_2, either.

Its species association is, anyway, as shown by the namegiving species of the sub-association, as well, a strongly pastured and trodden area.

Zone 3 can be characterized, here too, by the appearance of the solonetz layers.

In the direction of the meander No. 6, the accumulation level of solonetz is immediately on the surface, and the terrace-layer was dominated in the rough solonchak meadow solonetz by *Camphorosmetum annuae*, while on the opposite side by *Artemisio-Festucetum pseudovinae camphorosmetosum* that is characteristic of the meadow rough solonetz becoming moderately steppe like.

Approaching backwater 5, there followed a sector eroded by soil water, in whose zone forming the deepest relief the meadow soil of *Agrosti-Alopecuretum limonietosum*, getting more and more a solonetz character, can be found, marking similarly this zone, resp. the level of its terrace at the rims of the two meanders. That, however, resulted, owing to the gradual eluviation, in the typical appearance of the association. The vegetation cover developed in the higher layer round this zone is characterized partly by the solonetz layer got to the surface partly by the alkali silt.

Table 5. *Achilleo-Festucetum pseudovinae cynodontetosum*

Soil depth in cm	Arany's fixity	Humus	Calcium carbonate	Total salt	Sodic alkalinity
		per cent			
0— 5	67	4.82	0	0.02	0
5—10	60	4.20	0	0.02	0
10—20	46	2.92	0	0.02	0
20—40	46	2.06	0	0.02	0
40—60	48	1.22	0	0.05	0
60—80	49	0.43	15.04	0.07	0
Achilleo-Festucetum pseudovinae alopecuretosum					
0—10	55	3.87	0	0.02	0
10—20	48	2.86	0	0.06	0
20—40	67	1.72	0	0.10	0
40—60	68	1.08	2.08	0.15	0.02
60—80	79	0.93	7.52	0.15	0.09
Agrosti-Alopecuretum pratensis limonietosum					
0—10	51	3.23	0	0.03	0
10—20	52	2.54	0	0.08	0
20—40	59	1.74	0	0.14	0
40—60	67	1.80	2.14	0.25	0.04
60—80	72	1.44	5.12	0.60	0.06

Backwaters 5 and 6 have deeper and constant water, therefore in the bed of meanders partly the associations of Glycerietum maximae, partly those of *Scirpo-Phragmitetum typhetosum* became dominant, as seen in case of the Bega-backwater lying West of Zrenjanin.

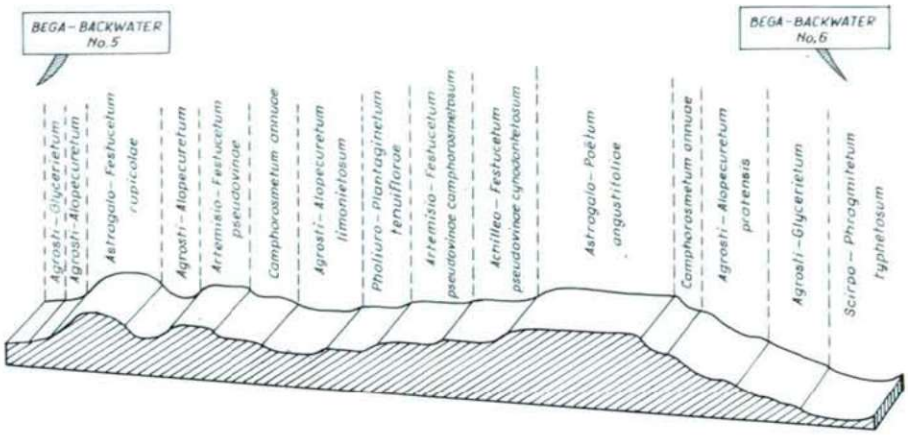


Fig. 8. Zonation conditions of the vegetation cover between Bega-backwaters 5 and 6.

Summary

In the course of the synecological investigation of the halophilic vegetation of the Pannonicum, the area of the Bega-backwaters in the Voivodina in Yugoslavia was elaborated. The task was to clarify the zonation conditions of the halophilic and glycophilic grass cover along some meander reaches chosen in the region of Zrenjanin.

During the investigations it was proved again that between the characteristic features of the zones of zigzagged limits lying terrace-like and the vegetation cover a close connection can be demonstrated here, too. After comparing the results of elaboration of three areas lying between backwaters rather far from one another, the following facts could be ascertained.

1) The outstanding ridges of the relief between the backwaters may be regarded as zone 1. In its meadow chernozem soil that does not get alkali, *Astragalo-Poëtum angustifoliae,* resp. *Achilleo-Festucetum pseudovinae* typicum can be found. This zone may sporadically missing or can appear island-like.

2) The zones lying below it have in the depth saline, resp. meadow solonetz soils becoming more and more steppe-like. Its vegetation cover developed partly of glycophilic species rooted in the surface soil of the eluviated A-layer, partly of deeply rooted halophilic species reaching the solonetz layer. Their phytocoenoses can be placed among *Achilleo-Fectucetum pseudovinae artemisietosum,* resp. *limonietosum,* and *Artemisio-Festucetum.*

3) In the meadow solonetz of zone 3 becoming roughly solonchak steppe-like, *Artemisio-Festucetum pseudovinae camphorosmetosum, Camphorosmetum annuae,* resp. its *Puccinellia limosa* sub-association could be observed.

4) In zone-groups of salt subsoil under hydrographically favourable conditions *Agrosti-Alopecuretum limonietosum,* in weakly saline soils *Agrosti-*

Alopecuretum typicum, *Agrosti-Glycerietum*, and *Agrosti-Beckmannietum* were to be found.

5) In the alkali silt of meander reaches in state of drying out, *Pholiuro-Plantaginetum tenuiflorae*, resp. *Heliotropio-Verbenetum supinae chenopodietosum* could be found.

The single zones can be formed under artificial conditions, as well. The craters of the bombs of air-raids fallen two decades ago on various alkali soils proved to be very suitable for investigating these.

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DIE FLECHTENVEGETATION UND FLECHTENZÖNOSEN DES ARBORETUMS IN SZARVAS

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Im Laufe der systematischen Bearbeitung der Flechtenvegetation der im Gebiet des Stromsystems der Theiss angelegten Arboreten kommt jetzt nach dem Botanischen Garten in Szeged (GALLÉ, 1966) und dem Arboretum in Tiszakürt (GALLÉ, 1967), die Besprechung der Flechtenarten und Flechtenzönosen des Arboretums in Szarvas an die Reihe. In diesen Ziergarten entwickelte sich eine merkwürdige und zum Vergleich geeignete Flechtenvegetation an den Stämmen der von allen Gegenden der Welt zusammengetragenen *Gymnospermen* und Laubhölzern. Ausser den Epiphytenflechtenarten und Flechtenzönosen ist die Anzahl der auf dem Erdboden lebenden und felsenbewohnenden Arten verschwindend gering. Deshalb bespreche ich, auch von dem Gebiet des Arboretums in Szarvas, zunächts die Vorkommens- und zönotische Umstände der epiphyten Flechten.

Entstehung des Arboretums

Das Arboretum in Szarvas, bzw. sein Vorläufer, das im Gebiet der Wirtschaft zu Bikazug liegende Anna-wäldchen wurde von der Familie Bolza angepflanzt. Die Anfangsarbeiten knüpfen sich — in der Ferne beinahe eines Jahrhunderts — an den Namen von J. BOLZA; das gegenwärtige Arboretum wurde aber aus dem Anna-Wäldchen grösstenteils von P. BOLZA versetzt, bzw. übersiedelt. Eine grossangelegte Ansiedlungsarbeit konnte erst nach der in den Jahren 1887/88 beendeten Kőrösregulierung angefangen werden, als die Baumpflanzungarbeiten von den bis dann jährlich wiederkehrenden Überschwemmungen nicht mehr bedroht wurden. Eine systematische Baumanlage begann erst um 1920, als im Gebiet des Arboretums von prominenten Fachleuten ein aus berühmten inländischen und ausländischen Garten stammendes Pflanzenmaterial engeführt wurde. Gegenwärtig werden im Arboretum 1300 verschiedene Pflanzen, hauptsächlich zahlreiche Holzarten kultiviert.

Geographische Faktoren, klimatische Verhältnisse

Das Arboretum in Szarvas, der sog. „Pepi-Garten" liegt im Gebiet des Komitats Békés, in der Gemarkung der Grossgemeinde Szarvas, ungefähr 1 km von der Gemeinde. Sein gegenwärtiges Gesammtgebiet beträgt zusammen mit der Vermehrungsanlage und der Baumschule 145 Katastraljoch, wovon ein Gebiet von 85 Katastraljoch auf den bewaldeten und als Park angelegten Teil fällt. Seine Meereshöhe beträgt 72,7 m. Sein Boden ist ein stark bindiger Gussboden mit sodahaltigen Flecken.

Die klimatischen Verhältnisse des Arboretums entsprechen dem extremen Klima der Tiefebene. Die Luftfeuchtigkeit des Gartens wird jedenfalls, ausser der waldartigen Baumanlage, auch durch die ständige Verdampfung der Wasseroberfläche der den östlichen Teil des Arboretums begrenzenden Toten-Kőrös erhöht. Die Jahresniederschlagsmenge beträgt im durchschnitt von 50 Jahren 548 mm, ist also sehr niedrig, und auch ihre Verteilung ist ungleichmässig. Die niederschlagfreien, trockenen Perioden sind häufig. Die Jahresnormaltemperatur beträgt, ebenfalls in einem 50-jährigen Durchschnitt, 11 °C. Im Winter kam auch eine Kälte von —26, —28 °C und als Sommermaximum eine Wärme von 38—39 °C vor.

Die Flechtenvegetation des Gebietes

Vom Gebiet des Arboretums berichtete die inländische Fachliteratur bisher nur über drei Flechtenarten *(Parmelia fuliginosa, P. sulcata, Ramalina fraxinea)*, die L. TIMÁR in den Jahren 1950, 1951 und 1952 gesammelt und Ö. SZATALA bestimmt hat, (Vgl. TIMÁR apud GALLÉ, 1960). Zusammen mit dieses Taxons sind vom Arboretum in Szarvas bisher 45 Flechtenarten und zahlreiche Varietäten von diesen vorgekommen, von denen 4 felsenbewohnend, 2 auf dem Erdboden lebend und 39 rindenbewohnend sind. 16 Arten, 8 Varietäten un 8 Formen wurden auch von F. FÓRISS (Miskolc) anlätzlich seiner älteren Sammlung gefunden. Nachstehend geben wir die Liste der von ihm gesammelten und zur Veröffentlichung überlassenen Flechtentaxons an:* *Buellia punctata* f. *punctiformis*, var. *chlorosa; Evernia prunastri; Hypogymnia physodes* v. *granulata* f. *papillosa; Lecanora carpinea* v. *cinerella*, v. *leptyrea*, v. *chondrotypa; Lecidea elaeochroma, L. glomerulosa; Opegrapha* sp.; *Parmelia acetabulum* f. *carneola; P. dubia* f. *furfuracea; P. sulcata; Peltigera canina* f. *leucorrhiza; Physcia aipolia* f. *caesionigra*, f. *melanophtalma; Ph. grisea* v. *hillmanni; Ph. orbicularis* v. *cycloselis*, v. *virella; Ph. tenella; Xanthoria parietina* f. *polyphylla*, v. *ectanoides.*

Von den Vorkommenden Arten ist die *Physcia tribacia*, die im Gebiet des Arboretums am Stamm von *Fraxinus excelsior* vorkommt, hervorzuheben. Ich habe sie im Botanischen Garten in Szeged vom Stamm der *Populus nigra* ssp. *italica* gleichfalls gesammelt, aber im Arboretum in Tiszakürt kam sie nicht vor. Auch das Vorkommen der *Peltigera canina* f. *leucorrhiza* „im öden Gras" (FÓRISS) soll hier erwähnt werden. Diese Art ist in einem moosigen Boden oder auf der Oberfläche von moosigen, sich ins Bodenniveau gezogenen Felsen in unseren Gebirgswäldern verbreitet. Ich habe sie weder in dem Botanischen Garten in Szeged, noch im Arboretum in Tiszakürt gefunden, aber ich habe sie in den 1930-er Jahren in dem in der Nähe von Szeged liegenden Wald von Ásotthalma am Rande eines aus *Pinus nigra* bestehenden älteren Tannenwäldchens gesammelt.

Es liegt hahe, einen interessanten Vergleich zwischen den auf den Rinden der speziellen Holzarten des Arboretums in Szarvas und anderer Gärten

* Für die gütige Überlassung und die vergleichende Revision einige Flechtenexemplare spreche ich auch hier aufrichtigen Dank aus.

Vorkommen der epiphyten Flechten- und Moos-Arten

Name der Flechten- und Moos-Arten	An Stamm von																																							
	Gymnospermatophytae						*Angiospermatophytae*																																			
	Abies alba	*Biota orientalis*	*Gingko biloba*	*Juniperus virginiana*	*Pinus strobus*	*Taxodium distichum*	*Acer lasiocarpa*	*— monspessulanum*	*— platanoides*	*— pseudo-platanus*	*— tataricum*	*Ailanthus altissima*	*Aesculus hippocastanum*	*Betula alba*	*Celtis occidentalis*	*Fagus silvatica*	*Fraxinus excelsior*	*— pennsylvanica*	*Gleditsia triacanthos*	*Juglans regia*	*Magnolia soulangiana*	*Populus alba*	*— nigra*	*— simonii*	*Quercus cerris*	*— petraea*	*— robur*	*— rubra*	*Robinia pseudo-acacia*	*Salix babylonica*	*Tilia europaea*	*Ulmus scabra*	*Wistaria chinensis*
a) *Lichenophyta*																																								
Arthonia dispersa									△	△																														
— radiata			+				+		+											+																			
Buellia punctata	+			+	+																																		
Caloplaca pyracea																				+		△						+											
— cerina																				+		△																	
Candelaria concolor													+							+																			
Evernia prunastri																									+	+		+		+		+							+
Hypogymnia physodes	+											○	△	+					+	△					+			+	+	+	△								
Lecania cyrtella							+																																	
Lecanora allophana																				△				+				+											
— carpinea									△		+		△		+	+		+	+	△		△		+	△			+	+	+	+	+	+						+
— pallida																			+		+										+								
— subfuscata							+	+												+											+								
Lecidea elaeochroma	+					+													+	+				+			+	+	+										
— glomerulosa						+				+			+			+				+			+					+		+									
Lepraria candelaris		△				+												+																					
Opegrapha species															+																								
Parmelia acetabulum																																							
— caperata																									△	+				+									
— dubia						△														+						+				△									
— fuliginosa						△			△							△										△		+		△									
— glabra																+				△							△												
— subargentifera													△			△										△		△			+								
— sulcata						○	△	△				△		+				△		△					△	○	△	+		○	△								
— tiliacea																+								+		△				△								
Pertusaria amara													+			+														△								
Physcia aipolia										△		△				△						△																
— ascendens										○	△	○					△			○		○		○		△			△									
— grisea						△				○	△	△				○				△																		
— leptalea										△			△															△										
— orbicularis						○				○	△					○			+	○		○	△	○		△			△									
— pulverulenta												△					+																					
— tenella						○							+							△								+									
— tribacia																△																					
Phlyctis argena					△								△	+	+											△				△								
Ramalina fraxinea																									+													
Rinodina pyrina																												+									
Xanthoria candelaria													△			○																					
— parietina						○				△	△	△				○	△			○		○	△	○				△			△						
b) *Bryophyta*																																							
Brachythecium salebrosum																△					○			△	△	△	+	△									
Leskea polycarpa																△									+	○			△								
Pylaisia polyantha													+			△					△			△		○	+									

entlang der Theiss lebenden Flechtenarten anzustellen. Es leben im Botanischen Garten in Szeged 32 Arten, im Arboretum in Tiszakürt 18 Arten und mehrere ihrer Varietäten an den Stämmen verschiedener Nadel- und Laubhölzer. Im Arboretum zu Szarvas hingegen, wie schon erwähnt, ist die Anzahl der Epiphyten Flechtenarten am reichsten: es kommen 39 Arten und zahlreiche ihrer Varietäten vor.

Ich habe die Flechtenarten und die im Arboretum am häufigsten vorkommemden Moose nach den Holzarten Gruppiert und in folgender Tabella zusammengefasst. In der Tabelle steht das Zeichen ○ für die oft vorkommenden, das Zeichen △ für die sporadisch erscheinenden un das Zeichen + für die seltenen Flechtenarten.

Wie aus der Tabelle ersichtlich, leben an den Stämmen der *Gymnospermen* viel wenigere Flechtenarten als an den *Angiospermen*, obzwar die Baumsammlung des Arboretums an *Gymnospermatophyten* sehr reich ist. Es ist auch auffällig, dass von den letzteren die reichste Flechtenbelegung am Stamm des *Taxodium distichum* vorkommt, das in Europa und in unserem Land nur in der geologischen Tertärperiode gelebt hatte und heute nur im atlantischen Nord-Amerika vorkommt. Bei uns wird es in den Parken, an Ufern gepflanzt. Von den *Angiospermen* machen sich die Flechten am liebsten am Nussbaum ansässig (18 Arten). Dies ist u. a. damit zu erklären, dass die Nussbäume voneinander weiter gepflanzt werden, wodurch ihre Stämme und Zweige genug Licht bekommen. Die an den Stämmen der Nussbäume dominierenden Lichtverhältnisse sichern für die Flechtenlagern, für die photosynthetische Tätigkeit in den Lagern lebenden Algenzellen (Gonidia) optimale Lebensverhältnisse. Etwas weniger, 14 Flechtenarten kommen an den *Fraxinus excelsior*-Stämmen vor. Dies ist eine Folge davon, dass die Eschenbäume in geschlossenen Bestand gepflanzt wurden und so sind die Lichtverhältnisse an den Stämmen, die übrigens für die Flechten eine sehr günstige physische Konsistenz haben, nicht so güntig für die Ansiedlung derselben, als auf den Nussbaumstämmen.

Untersuchen wir die quantitativen Verhältnisse der Flechtenbelegung der Einzelstämme und derjenigen, die in offener Lage und in geschlossenem Bestand gepflanzt wurden oder halbverschattet sind, so befinden sich ebenfalls die Bäume mit besser beleuchteten Stämmen in einer günstigeren Lage.

Ausser den in der Tabelle vorkommenden Epiphyten Flechtenarten habe ich auch *Cladonia chlorophaea*, eine Strauchflechte gesammelt, die auf dem Erdboden und auf den Stamm der *Gleditsia triacanthos* lebt und habe auf einem Kalksteinblock die epilitischen Arten *Caloplaca citrina*, *Candelariella aurella*, *Lecanora albescens* und *Verrucaria nigrescens* beobachtet.

Die epiphyten Flechtenzönosen des Arboretums

Im Arboretum in Szarvas kommen fünf epiphyten Flechtenzönosen vor, die ich in das System von KLEMENT (1955), bzw. BARKMAN (1958) eingeteilt habe:

Classis: **Epiphytetea lichenosa** KLEM. 1955.

Ordo: *Lecanoretalia variae* BARKM. 1958.

1. Synusium: *Phlyctis argena syn.*

1. Associatio: *Lecanoretum carpineae continentale* (GALLÉ 1930) BARKM. 1958.

Ordo: *Arthonietalia radiatae* BARKM. 1958.

Foederatio: Graphidion scriptae (OCHSN. 1928) em. BARKM. 1958.

2. Associatio: *Arthonietum dispersae* GALLÉ 1935.

Ordo: *Physcietalia ascendentis* MATT. 1951. em. BARKM. 1958.

Foederatio: Xanthorion parietinae OCHSN. 1928. em. BARKM. 1958.

3. Associatio:*Xanthorietum candelaris* (GAMS 1927) BARKM. 1958.

4. Associatio: *Physcietum ascendentis* FREY et OCHSN. 1926.

Die associationswertigen Zönosen erscheinen hauptsächlich auf den Stämmen von frei stehenden Bäumen und das Synusium in Auen geschlossenen Bestandes, bzw. auf den Stämmen der Bäume das der Arboretum beschützenden Waldzone.

Die in einer synthetischen Liste zusammengefasste Zusammensetzung, zbw. die kurze Charakterisierung der einzelnen Zönosen seien nachstehend angeführt:

Phlyctis argena synusium

Charakterarten:

Sk *Phlyctis argena*, Sk *Phl. agelaea(?)*

Verbandscharakterarten:

Ex *Lecanora carpinea*, Ex *L. subfuscata*, Ex *L. pallida*

Ordnungscharakterarten:

Ex *Lecidea glomerulosa*, Sk *Pertusaria amara*, Ra *Evernia prunastri*

Klassencharakterarten:

Pa *Parmelia sulcata*, Pa *Hypogymnia physodes.*

Biologisches Spektrum: Ex 40, Sk 30, Pa 20, Ra 10%.

Das Synusium ist schattenliebend und dementsprechend kommt es auch im Arboretum in Szarvas in Wäldchen mit geschlossenem Bestand auf der nicht zu rissigen Rinde der Stämme von *Tilia europaea, Aesculus hippocastanum* und *Quercus robur*, bzw. fragmentarisch von *Pinus strobus* vor. Die Anzahl der das Synusium bildenden Arten ist niedrig. Das Vorkommen der Charakterart *Phlyctis agelaea* ist zweifelhaft und die *Lecanora chlarona*, *Pertusaria globulifera* Arten kommen in diesem Fundort nicht vor.

Lecanoretum carpineae continentale (GALLÉ) BARKM.

Charakterarten:

Ex *Lecanora carpinea*, Ex *Caloplaca cerina.*

Verbandscharakterarten:

Ex *Lecanora allophana*, Ex *Buellia punctata*, Ex *Lecanora pallida*, Ex *Rinodina pyrina*, Sk *Phlyctis argena.*

Ordnungscharakterarten:

Ex *Lecidea elaeochroma*, Sk *Pertusaria amara*, Pa *Xanthoria parietina*,

Pa *Physcia ascendens*, End *Arthonia radiata*.

Klassencharakterarten:

Pa *Parmelia sulcata*, Pa *Hypogymnia physodes*.

Biologisches Spektrum: Ex 50, Pa 29, Sk 14, End 7%.

Die das diffuse Licht liebende, neutrophile Flechtenzönose ist im ganzen Gebiet des Landes verbreitet und kommt auf Baumstämmen mit glatten oder nur ein wenig rissigen Rinden vor. Im Arboretum in Szarvas habe ich sie auf Stämmen von *Acer platanoides, A. tataricum, Aesculus hippocastanum, Fagus silvatica, Juglans regia, Tilia europaea, Salix babylonica, Celtis occidentalis, Populus alba, Quercus rubra, Fraxinus pennsylvanica, Fr. excelsior* teils gut, teils nur fragmentarisch entwickelt gefunden. Es sei erwähnt, dass in diesem Gebiet von den Charakterarten die *Bacidia rubella*, von den Verbandscharakterarten die Krustenflechte *Candelariella vitellina* fehlen; unter den Ordnungscharakterarten wird die *Pertusaria globulifera* mit *Pertusaria amara* ersetzt, was auf die ökologischen Verhältnissen des in der Tiefebene liegenden Arboretums zurückzuführen ist.

In Hinsicht der Sukzessionsverhältnisse wird es klar, dass die Pionierarten der Assoziation den Charakterarten des *Arthonietum dispersae* entsprechen, während die weitere Entwicklung in die Richtung des *Physcietum ascendentis* zeigt.

Arthonietum dispersae GALLÉ

Charakterarten:

End *Arthonia dispersa*, End *Arthonia radiata*.

Verbandscharakterarten:

Sk *Candelaria concolor*, Sk *Lepraria candelaris*,

Ordnungscharakterarten:

Ex *Lecidea elaeochroma*, Ex *Lecanora carpinea*.

Klassencharakterarten:

Pa *Parmelia sulcata*, Pa *Hypogymnia physodes*.

Begleiter:

Pa *Xanthoria parietina*, Pa *Physcia ascendens*, Pa *Physcia orbicularis*.

Biologisches Spektrum: End 25, Ex 25, Sk 25, Pa 25%.

Diese photophile Flechtenassoziation, die ziemlich xerophytisch aber weniger nitrogentolerant ist, habe ich erst im Theiss—Maroswinkel (GALLÉ, 1960) beobachtet, auf den Stämmen und auf den Zweigen von Laubbäumen mit glatten Rinden. Unter denselben Umständen erscheinen sie auf den alleinstehenden, jungen *Acer platanoides, A. lasiocarpa* und *Juglans regia*-Stämmen auch im Arboretum in Szarvas. Ein Unterschied zeigt sich in den Verbandscharakterarten nur darin, das hier keine *Polyblastiopsis fallaciosa* species vorkommt, unter den Klassencharakterarten hingegen auch *Hypogymnia physodes* erscheint.

Xanthorietum candelariae FREY

Charakterarten:

Sk *Xanthoria candelaria*.

Verbandscharakterarten:

An *Physcia ascendens*, Pa *Parmelia fuliginosa*, Pa *P. glabra*, Pa *Xanthoria parietina*.

Ordnungscharakterarten:

Ex *Lecanora subfuscata*, Ex *L. carpinea*, Ex *Lecidea elaeochroma*, Sk *Pertusaria amara*.

Klassencharakterarten:

Pa *Parmelia sulcata*, Pa *Hypogymnia physodes*.

Biologisches Spektrum: Pa 46, Ex 28, Sk 17, An 9%.

Auch diese Flechtenzönose ist eine photophile, mild nitrogentolerante Assoziation, die auf älteren Bäumen mit rissig-schrundigen Rinden, wie *Aesculus hippocastanum* und *Fraxinus excelsior* erscheint. Ihre Artenliste ist ein wenig kürzer als in anderen Fundorten an der Theiss und steht den von FREY (1937) und KLEMENT (1955) beschriebenen und aus schweizerischen und westeuropäischen Fundorten stammenden Zönosen näher.

Physcietum ascendentis FREY et OCHSN.

Charakterarten:

An *Physcia ascendens*, An *Ph. tenella*, Pa *Ph. pulverulenta*, Pa *Ph. orbicularis*, Pa *Ph. stellaris*, Pa *Ph. grisea*, Pa *Ph. leptalea*, Pa *Ph. aipolia*.

Verbandscharakterarten:

Pa *Xanthoria parietina*, Sk *Candelaria concolor*, Pa *Parmelia fuliginosa*, Sk *Xanthoria candelaria*, Pa *Parmelia acetabulum*, Pa *P. tiliacea*.

Ordnungscharakterarten:

Ra *Evernia prunastri*, Ex *Lecanora subfuscata*, Ex *Lecidea glomerulosa*, Ex *Buellia punctata*, Ex *Lecanora carpinea*, Sk *Pertusaria amara*, Ex *Caloplaca cerina*, Ex *C. pyracea*, Ex *Rinodina pyrina*.

Klassencharakterarten:

Pa *Parmelia sulcata*, Pa *Hypogymnia physodes*.

Biologisches Spektrum: Pa 48, Ex 28, Sk 12, An 8, Ra 4%.

Die aus den aufgeführten Arten bestehende Flechtenzönose ist die charakteristishceste Flechtenassoziation der Grossen Ungarischen Tiefebene, mit einem breiten ökologischen Spektrum. Im Arboretum in Szarvas kommen auf den älteren Bäumen mit einer rissig-unebenen Rinde die Varietäten, bzw. auch die Subassoziationen des *Physcietum xanthoriosum parietinae* und *Physcietum parmelietosum physodis* vor.

Unter den Charakterarten der typischen Assoziation habe ich an den Stämmen der Bäume des Arboretums unter den Verbandscharakterarten die *Parmelia exasperatula*, unter den Ordnungscharakterarten die *Ramalina species* — die übrigens jetzt schon aus dem ganzem Arboretum fehlen — nicht gefunden und fand auch die Candelariella vitellina nicht. Es erscheinen hingegen einige Laubflechten unter den begleitenden Arten, wie dies auch der obigen Zusammenstellung zu entnehmen ist.

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WIRKUNG DER SPEKTRALZUSAMMENSETZUNG DES LICHTS AUF DIE GEWEBESTRUKTUR DER CAPSICUM-, FAGOPYRUM-, PHASEOLUS- UND VICIA-ARTEN

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Einführung

Durch die Qualität, bzw. Spektralzusammensetzung des Lichts kann auf die Pflanzen eine beachtliche Wirkung ausgeübt werden. Auf Grund unserer früheren Untersuchungen (HORVÁTH, 1965) haben wir nachgewiesen, dass durch diesen Faktor eine grössere Wirkung erzielt werden könne als mit einem Licht identischer Spektralzusammensetzung aber verschiedener Energie, mit Rücksicht auf die Energie, die sich durch die photosynthetischen Pigmente absorbieren lässt.

Diese Wirkungen sind jedoch viel eher in Bezug auf den Stoffwechsel bekannt und besonders wenig wissen wir von der auf die Gewebestruktur ausgeübten Wirkung dieser Faktoren.

LJEMAN (1955) hat festgestellt, dass unter dem Einfluss das blaue Licht im Stengel der Tomate und der Bohne eine höhere Differenzierung der Leitungsbündel, eine kräftigere Entwicklung der Festigungszellen und eine grössere Breite des Cambiums bewirke.

JANKOVICH (1956) untersuchte in Pflanzen verschiedener Familien *(Cruciferae, Compositae, Papilionaceae, Labiatae)* die Wirkung der spektralen Energieverteilung des Lichts auf die Gewebestruktur des Stengels. Er fand den grössten Unterschied in der Grösse und Anzahl der Gefässbündel. Die stärkere Entwicklung der Leitungsgewebe ist auf Kosten des Markgewebes eingetreten. Er zieht im Gegensatz zu Ljeman die Schlussfolgerung, dass die Quantität der Leitungsgewebe und des mechanischen Systems vom roten zum blauen Wellenbereich abnehme.

ZAAR (1961) erforschte die auf die Meristeme ausgeübte Wirkung des Lichts verschiedener Spektralzusammensetzungen bei der Bohne. Er hat festgestellt, dass die Tätigkeit des Vegetationspunkts von den roten und infraroten Strahlen (nm 650—750) erhöht, von den Kurzwellenstrahlen (nm 450—480) hingegen gehemmt werde, ja diese das Meristem sogar vernichtet.

Auf Grund der Ergebnisse unserer auf Bohnen, Erbsen und Sojapflanzen durchgeführten Forschungen (HORVÁTH, 1965; HORVÁTH et al., 1966) haben auch wir einiges über die auf die Gewebestruktur des Stengels ausgeübte Wirkung der Spektralzusammensetzung des Lichts festgestellt. So haben wir nachgewiesen, dass die relative Menge des Holzteils und des mechanischen Systems unter dem Einfluss des blauen Lichts am grössten ist. Diese Änderung tritt auf Kosten des Markparenchyms ein.

Schon diesen wenigen Hinweisen ist zu entnehmen, dass die Ergebnisse zum Teil widerspruchsvoll sind. Es ist ferner noch nicht ganz geklärt, wie allgemeingültig der Zusammenhang zwischen der spektralen Energieverteilung und der Gewebestruktur der Pflanzen bei unseren *Angiospermen* ist.

Im Laufe der Untersuchung der Stengel- und Blattstruktur der Gattungen *Vicia, Phaseolus, Fagopyrum* und *Capsicum* wollten wir zunächst eine Antwort auf die Frage erhalten, welche Wirkung innerhalb eines Organs auf die Anteilquote der einzelnen Gewebegegenden vom Licht verschiedener Spektralzusammensetzung ausgeübt werde.

Material und Methode

Unsere Forschungspflanzen (*Vicia faba* L., *Capsicum annuum* L. convar. *grossum*, provarietas *ovatum* conc. *hungaricum* TERPO c. v., *Phaseolus vulgaris* L., *Fagopyrum esculentum* MÖNCH.) wurden im Jahr 1967, im Botanischen Garten der Attila József Universität unter Freifeldumständen, in vier Wiederholungen gezüchtet. Das Licht verschiedener Spektralzusammensetzungen wurde durch eine farbige Folienbedeckung gesichert. Die 0,2 mm dicke Folien waren perforiert, um unter den Folien ein „Mikroklima" zu schaffen, welches — mit Ausnahme des Lichtes — den Naturverhältnissen am nähesten steht. Die farbige Folienbedeckung hat auf die spektrale Energieverteilung des Lichtes einen bedeutenden Einfluss ausgeübt. (Tab. 1) und auch die Intensität der Beleuchtung verändert (Tab. 2). Dies wurde bei der Bewertung unserer Ergebnisse in Betracht genommen.

Tabelle 1

Varianten	Energieverteilung im Prozent der auf den Wellenbereich nm 400—700 entfallenden Energie					
	1	2	3	4	5	6
unbedeckte Kontrolle	14	25	23	7	10	15
farblos	14	24	28	8	11	19
gelb	10	22	26	9	12	21
blau	22	32	28	5	5	14
rot	11	14	11	4	14	46
grün	9	28	35	6	8	14

1 = violettfarbig nm 400—436; 2 = blau 436—495; 3 = grün 495—566; 4 = gelb 566—589; 5 = orangengelb 589—627; 6 = rot 627—700.

Der Boden des Versuchsgebiets war Schluffgartenton. Um die optimale Entwicklung der Pflanzen zu sichern, haben wir im Juli (ausser dem durch die perforierte Folie eingedrungenen Regenwasser) wöchentlich zweimal auch eine Berieselung durchgeführt.

Das Einsammeln der für die histologischen Untersuchungen notwendigen Stengel- und Blatteile wurde gleichzeitig mit der Erscheinung der ersten Blüten ausgeführt. Die Muster der Stengelstücke wurden in den unteren Internodien von 5 bis 8 genommen. Die Blattmuster wurden bei *Capsicum* aus dem mittleren Drittel der in dem 7. Nodus, bei *Vicia* in dem 4. Nodus liegenden — vollentwickelten — Blättern genommen.

Nach Äthanolfixierung und Konservierung wurde der Versuchsstoff in Zelloidin eingebettet, bzw. aus den Blättern auch Epidermismazeration verfertigt. Die Schnitte sind mit Mikrotom verfertigt nach Reinigung mit Ehrlichs Eisenhämatoxylin progressiv gefärbt und in Kanadabalsam konserviert worden.

Tabelle 2

Varianten	Gesamtstrahlung in Prozent
unbedeckte Kontrolle	100
farblos	75
gelb	62
blau	38
rot	37
grün	32

Im Laufe unserer Untersuchungen haben wir folgende Gewebegegenden studiert:
in den Stengeln:
1. Epidermis + Rindenparenchym
2. Leitungsgewebesystem (Siebteil, Kambium, Holz)
3. Markparenchym
4. Markhöhle;

bei den Blättern:
1. obere Epidermis + Palisadenparenchym
2. untere Epidermis + Schwammparenchym
3. Anzahl der Stomata für 1 mm²
4. Anzahl der Epidermiszellen für 1 mm².

Die Anteilquote der erwähnten Gewebegegenden ist so bestimmt worden, dass die Stengel- und Blattquerschnitte aus dem Mikroskop projiziert und dann die zu untersuchenden Gewebegegenden auf Pauspapier umgezeichnet wurden. Nach dem Gewicht der Pauspapierstücke, welche die Gewebegegenden bedeuten, und des Pauspapiers bekannter Fläche, haben wir mit Berücksichtigung der Vergrösserung die Fläche und die Proportion der Gewebegegenden berechnet. Für die einzelnen Arten und Varianten wurden je 50 Messungen vorgenommen.

Besprechung und Bewertung der Ergebnisse

Stengelstruktur (Tab. 3)

Die Abweichungen zwischen den Varianten hinsichtlich der primären Rindengrösse (Rindenparenchyms) sind bei den Arten *Fagopyrum*, *Phaseolus* und *Vicia* von geringem Ausmass. Die Höchstabweichungen zwischen den beiden extremen Werten betragen 7%. Bei *Capsicum* sind die Unterschiede grösser, unter den roten Folien z. B. sind sie mehr als zweimal so gross, als bei der unbedeckten Kontrolle. Beim *Capsicum* wächst die Menge der primären Rinde in Richtung der längeren Wellenbreiten (Tab. 3).

Im Entwicklungsstand des Leitungsgewebesystems bei den untersuchten Arten kann eine 7—16%-ige Abweichung der Varianten beobachtet werden. Die Unterschiede sind je nach Arten und Varianten verschieden (Tafel I. 3—4 und Tafel II. 1—5). Das Leitungsgewebe ist am stärksten entwickelt bei *Capsicum* in den unbedeckten Kontrollparzellen, bei *Fagopyrum* unter den farblosen, und bei *Phaseolus* und *Vicia* unter den gelben Folien.

Innerhalb des Leitungsgewebesystems wurde die Grösse des Siebteiles bei *Capsicum* vom „roten", bei *Phaseolus* vom „gelben Licht" erhöht.

Es wird im allgemeinen diese Gewebegegend vom „blauen Licht" beschränkt. Die Wirkung der spektralen Energieverteilung auf das Siebgewebe war bei *Vicia* am kleinsten. Bei *Capsicum* übt die spektrale Zusammensetzung auf den Holzteil eine geringe Wirkung aus, die im allgemeinen mit der Ver-

grösserung der Wellenlänge abnimmt. Der Holzkörper der *Fagopyrum*- und *Phaseolus*stengel ist im „gelben Licht" am grössten. Die Unterschiede zwischen den extremen Werten belaufen sich bis auf 20%. Es ist festzustellen, dass die Wirkung der Spektralzusammensetzung auf das Leitungsgewebesystem nicht allgemein, sondern je nach den Arten verschieden ist.

Tabelle 3. Die Veränderung des Prozentsatzes der im Stengel befindlichen Gewebegegenden als Funktion der Spektralzusammensetzung des Lichts.

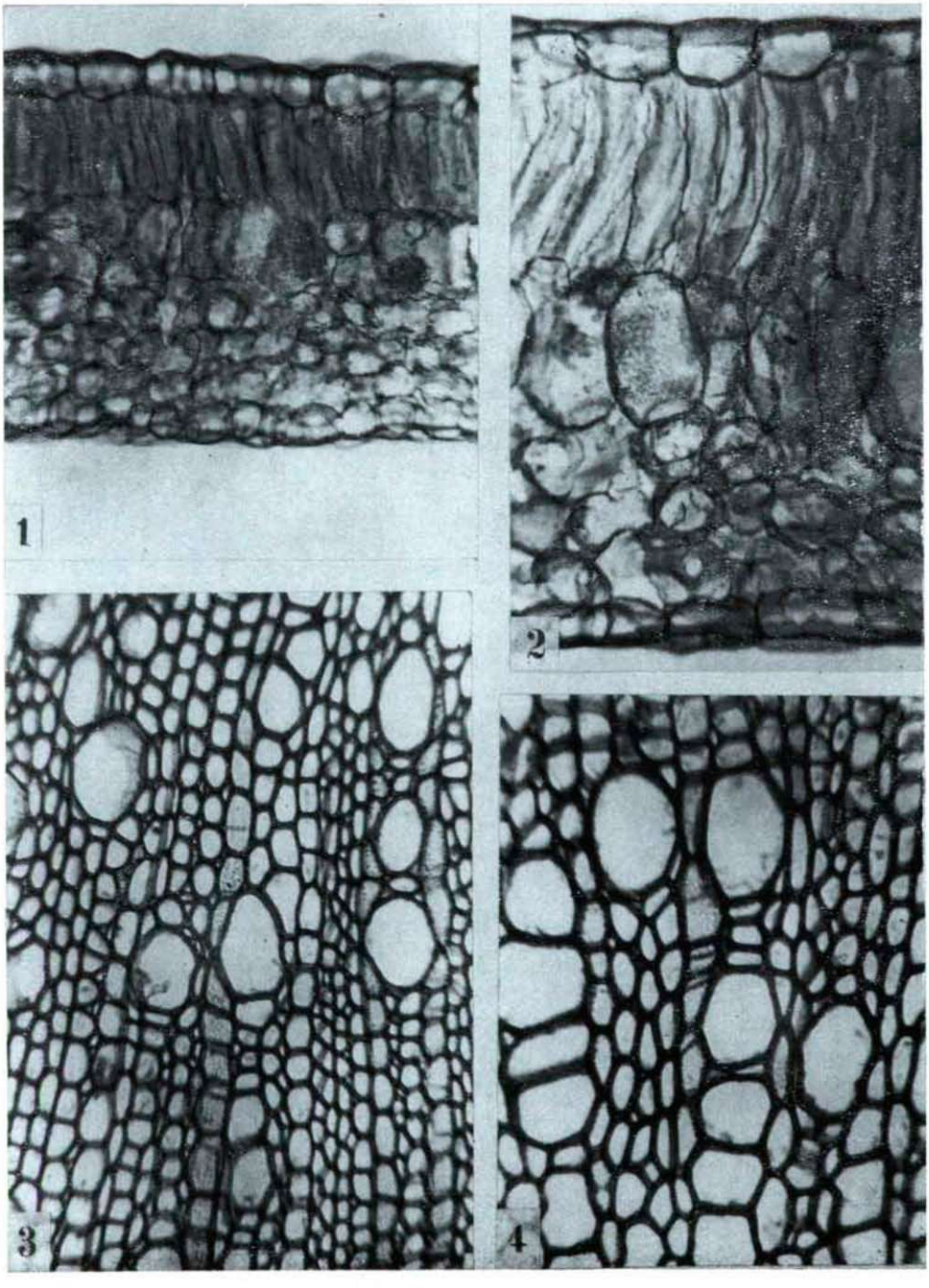
Varianten	Arten	Epidermis + Rinde	Leitungsgewebe: Siebteil	Leitungsgewebe: Holzteil	Markgewebe	Markhöhle
unbedeckte Kontrolle	*Capsicum*	24	8	42	26	—
	Fagopyrum	13	23		44	20
	Phaseolus	20	15	39	28	—
	Vicia	30	15	19	35	—
farblos	*Capsicum*	42	8	37	13	—
	Fagopyrum	14		25	46	15
	Phaseolus	18	15	32	35	—
	Vicia	36	12	17	35	—
gelb	*Capsicum*	42	8	31	19	—
	Fagopyrum	11		17	32	40
	Phaseolus	20	16	52	12	—
	Vicia	31	13	23	32	—
blau	*Capsicum*	25	5	35	35	—
	Fagopyrum	13	19		36	32
	Phaseolus	19	11	33	37	—
	Vicia	30	14	15	40	—
rot	*Capsicum*	49	11	30	10	—
	Fagopyrum	14	21		45	20
	Phaseolus	18	12	36	34	—
	Vicia	36	13	19	31	—
grün	*Capsicum*	39	8	35	18	—
	Fagopyrum	11	16		36	37
	Phaseolus	13	12	26	49	—
	Vicia	36	15	20	28	—

Dies bezieht sicht auch auf die Anteilquote des Markgewebes (Tafel. III. 1–4).

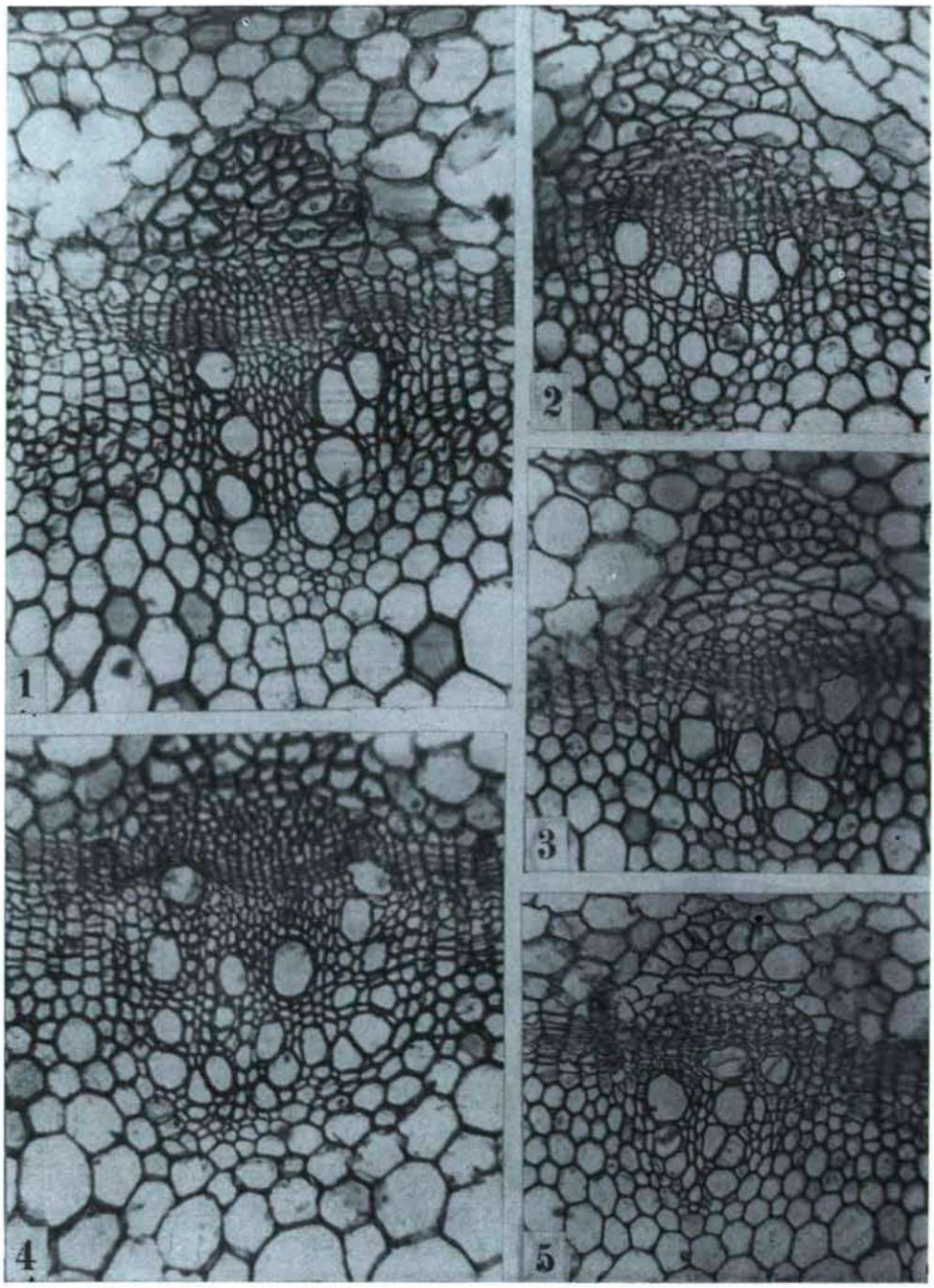
Es kann jedoch ein Zusammenhang zwischen dem Leitungsgewebesystem und den Parenchymgeweben (Rindenparenchym und Markparenchym) beobachtet werden. Wo das Leitungsgewebesystem entwickelt ist, ist die Anteil-

Tafel I. Abb. 1. *Capsicum* Blattquerschnitt, rote Variante, x 200.
Abb. 2. *Capsicum* Blattquerschnitt, gelbe Variante, x 200.
Abb. 3. *Capsicum* Holzteilquerschnitt. Kontrolle, x 200.
Abb. 4. *Capsicum* Holzteilquerschnitt. Rote Variante, x 200.

TAFEL I



TAFEL II



quote der Parenchymgewebe vermindert. Dies kann bei Vergleichung des Holzteils mit dem Markparenchym besonders deutlich beobachtet werden. Unsere früheren Untersuchungen werden dadurch bestätigt.

Es kann auch hinsichtlich in der Grösse der Markparenchymzellen ein bedeutender Unterschied beobachtet werden (Tafel. III. 1—4). So sind z. B. die Zellen des Markgewebes der in der unbedeckten Kontrollparzelle und im „gelben Licht" gewachsenen Stengel gross, abgerundet, oft mit Interzellularen; das Markgewebe der im „grünen Licht" gewachsenen Stengel wird hingegen aus kleineren, isodiametrischen dünnwändigen Zellen aufgebaut. Es gibt nur wenige Interzellularen.

Ein Unterschied lässt sich ausserdem im Verhältnis zwischen Markhöhle und Markparenchym beobachten. Bei Fagopyrum, wo dies untersucht wurde, ist im „gelben Licht" die Markhöhle am grössten und das Markgewebe am kleinsten. Unter farblosen Folien ist aber die Lage umgekehrt. Der Unterschied betreffs der Markhöhle ist bei den zwei Varianten extremen Wertes beinahe dreifach. Daraus ist auch darauf zu schliessen, dass selbst die Tätigkeit des Markmeristems von der spektralen Energieverteilung des Lichtes beeinflusst wird.

Es mag sich die Frage stellen, ob die festgestellten Unterschiede mit der spektralen Energieverteilung des Lichtes in Zusammenhang gebracht werden können, da in unseren Freilandversuchen unsere Varianten sich voneinander nicht nur in der spektralen Energieverteilung, sondern auch in der Stärke der Beleuchtung unterschieden. Es kann festgestellt werden (Tabelle 3), dass zwischen dem Verhältnis der Veränderungen und der abnehmenden Reihe der Beleuchtungsstärke (Tabelle 2) im allgemeinen keine Parallele beobachtet werden kann. Zwischen den Wirkungen der blauen und roten Folien — die praktisch ein identisches Energieniveau bedeuten — gibt es wesentliche Unterschiede. Z. B. beträgt bei *Capsicum* die Anteilquote der Epidermis + Rindenparenchyms in „blauem Licht" 25%, unter roten Folien 49%. Die Quote des Markparenchyms bei derselben Pflanze beträgt unter den blauen Folien 35, unter den roten 10%. Demzufolge sind die Veränderungen eher mit der spektralen Energieverteilung in Zusammenhang zu bringen und ist die Wirkung der Beleuchtungsstärke von kleinerer Bedeutung. Es würder jedoch nur die auf einem identischen Energieniveau ausgeführten Untersuchungen einen entscheidenden Beweis bedeuten, die aber unter Freibodenkultur kaum durchführbar sind.

Blattstruktur

Bei den *Capsicum*- und *Vicia*-Arten (Tabelle 5) wurke die Anzahl der auf der Oberseite und der Unterseite des Blattes befindlichen und auf die Flächeneinheit fallenden Epidermiszellen durch die Bedeckung mit farbigen Folien im allgemeinen vermindert. Das Mass der Verminderung ist in der Oberepidermis grösser und bei *Capsicum* betrug es sogar die 50%.

Tafel II. Abb. 1. Gefässbündel des Stengelquerschnitts von *Vicia*. Kontrolle, x 200.
Abb. 2. Gefässbündel des Stengelquerschnitts von *Vicia*. Farblose Variante, x 200.
Abb. 3. Gefässbündel des Stengelquerschnitts von *Vicia*. Blaue Variante, x 200.
Abb. 4. *Vicia* Stengelquerschnitt. Gelbe Variante, x 200.
Abb. 5. Gefässbündel des Stengelquerschnitts von *Vicia*. Grüne Variante, x 200.

Bei *Vicia* gibt es mehr Zellen pro Flächeneinheit auf der Unterseite, bei *Capsicum* auf der Oberseite des Blattes. Auch diese „vererbliche" Arteneigenheit wurde von der spektralen Energieverteilung beeinflusst.

Auch die Anzahl der Stomata pro Flächeneinheit wurde durch die Bedeckung mit farbigen Folien vermindert. Auch diese Wirkung ist bei *Capsicum* stärker, besonders auf der Oberepidermis. Es ist zu erwähnen, dass die Wirkung des „blauen Lichts" auf die Epidermen der zwei Arten gegensätzlich ist (bei *Capsicum* ist z. B. die Zahl der Stomata auf der Unterepidermis im „blauen Licht" am kleinsten, bei *Vicia* jedoch ist sie den bedeckten Varianten hier am grössten).

Das Blattmesophyll ist bei beiden Arten bifaziell heterogen. Oben liegt ein Palisadenparenchym bestehend aus einer Zellschicht, unten ein Schwammparenchym von mehreren Zellenreihen. Die unter dem Einfluss der Spektralzusammensetzung des Lichts eingetretene Veränderung der Anteilquote des Palisaden- und Schwammparenchyms auf Tabelle 4 veranschaulicht, der zu entnehmen ist, dass in den unter den Folien gewachsenen Blättern die Palisadenparenchymschicht im Vergleich zu den Kontrollblättern dicker, das Schwammparenchym aber dünner wurde. Das Ausmass des Unterschieds scheint aber nicht bedeutend zu sein.

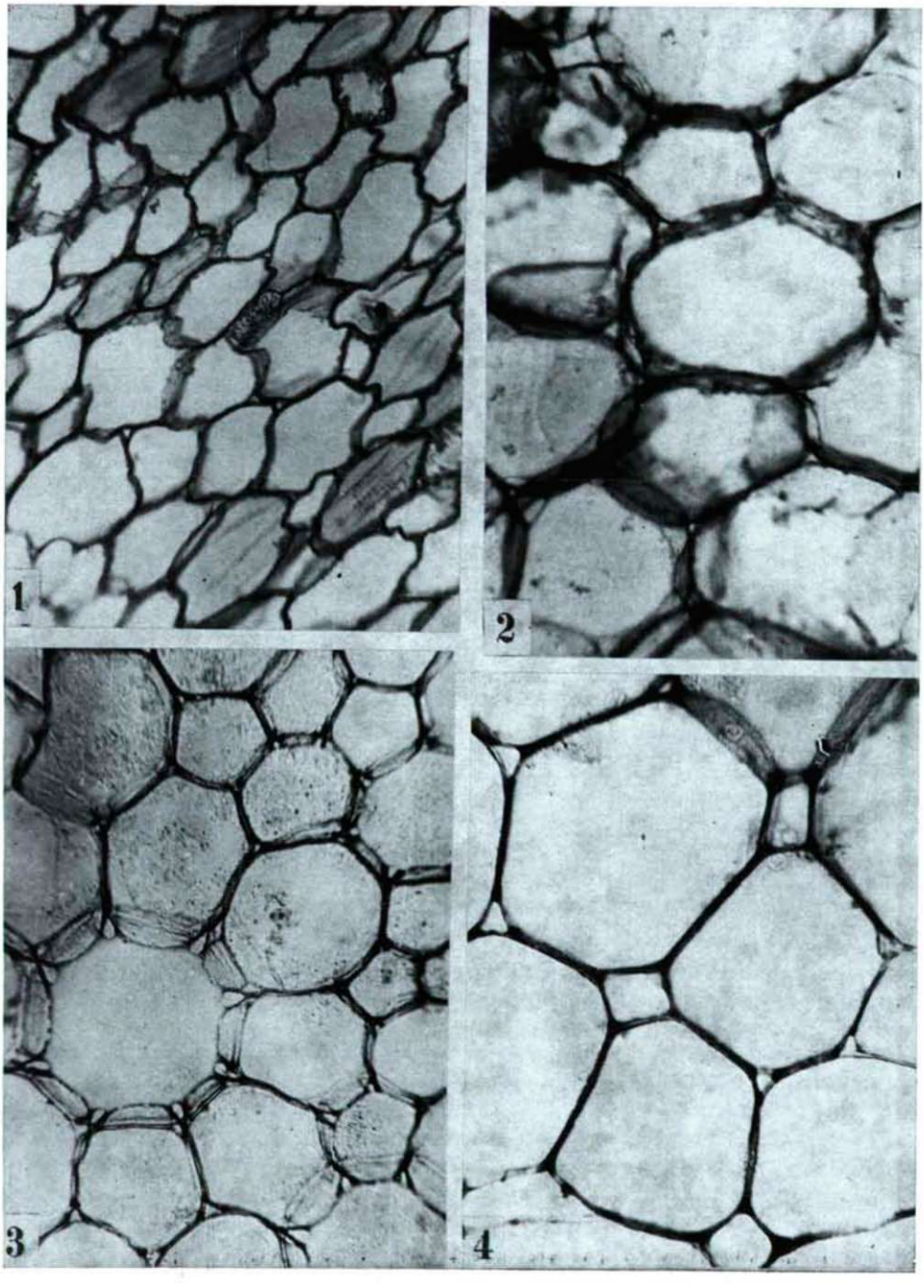
Die Vergrösserung der Schichtdicke des Palisadenparenchyms lässt sich auf die Verlängerung der Zellen zurückführen (Tafel I. 1–2). Diese Schicht ist aber auf den bedeckten Parzellen im Vergleich zur Kontrolle lockerer, enthält mehr interzellulare Substanz.

Tabelle 4. Veränderung der prozentualen Anteilquote der Blattgewebegegenden als Funktion der Spektralzusammensetzung des Lichts.

Varianten	Arten	Oberepidermis + Palisadenparenchym	Unterepidermis + Schwammparenchym
unbedeckte Kontrolle	*Capsicum*	42	58
	Vicia	40	60
farblos	*Capsicum*	42	58
	Vicia	48	52
gelb	*Capsicum*	49	51
	Vicia	43	57
blau	*Capsicum*	46	54
	Vicia	46	54
rot	*Capsicum*	42	58
	Vicia	41	59
grün	*Capsicum*	48	52
	Vicia	44	56

Tafel III. Abb. 1. *Capsicum* Markparenchyms. Kontrolle, x 200.
Abb. 2. *Capsicum* Markparenchym. Rote Variante, x 200.
Abb. 3. *Phaseolus* Markparenchym. Grüne Variante, x 250.
Abb. 4. *Phaseolus* Markparenchym. Farblose Variante, x 250.

TAFEL III



Es ist festzustellen, dass, ähnlich wie im Fall des Stengels, die Spektralzusammensetzung des Lichts auch auf die Gewebestruktur der Blätter wirkt, und zwar zunächst auf die Epidermis. Besonders die auf die Anzahl der stomata ausgeübte Wirkung scheint dem Gaswechsel zufolge wichtig zu sein.

Die Abnahme der Zahl der Stomata zeigt einen Zusammenhang auch mit der Verminderung der Beleuchtungsstärke und auch die Spektralzusammensetzung des Lichts scheint eine bedeutende Wirkung auszuüben. Dies wird auch vom Unterschied zwischen den blauen und roten Folien gut gezeigt (Tabelle 5).

Aus unseren Untersuchungen kann auch festgestellt werden, dass der Lichtfaktor auf die Gewebestruktur des Stengels eine Wirkung grösseren Masses ausübt als auf das Blatt.

Tabelle 5. Wirkung der Spektralzusammensetzung des Lichts auf die Zahl der Epidermiszellen und Stomata der Oberseite und der Unterseite (auf 1 mm²)

Varianten	Arten	Anzahl der Stomata		Anzahl der Epidermiszellen	
		Ober-	Unter-	Ober-	Unter-
		seite			
unbedeckte Kontrolle	*Capsicum*	36	109	400	420
	Vicia	28	37	133	105
farblos	*Capsicum*	12	85	275	310
	Vicia	24	26	114	87
gelb	*Capsicum*	28	74	330	302
	Vicia	18	28	106	92
blau	*Capsicum*	27	36	308	300
	Vicia	23	32	105	112
rot	*Capsicum*	10	65	210	250
	Vicia	22	26	97	85
grün	*Capsicum*	22	45	208	230
	Vicia	21	23	100	78

Zusammenfassung

In Freiboden versuchen wurde unter farbigen Kunststoff-Folien die Wirkung des spektralen Energieverteilung des Lichts auf die Gewebestruktur der Stengel und Blätter von *Capsicum, Fagopyrum, Phaseolus* und *Vicia* untersucht.

Es lässt sich feststellen:

1. Die Spektralzusammensetzung des Lichtes übte eine Wirkung auf die Gewebestruktur des Stengels aus, das Ausmass der Wirkung ist aber je nach den Arten verschieden.
1.1. Auf die Parenchymgewebe wird eine grössere Wirkung ausgeübt als die auf die Leitungsgewebe.
1.2. Zwischen den Mengen des Rinden- und des Markparenchyms besteht ein enger Zusammenhang: die Vergrösserung des einen zieht die Verminderung des anderen nach sich. Der Gesamtparenchymgehalt der Stengel verändert sich also weniger.

1.3. Innerhalb des Leitungsgewebesystems ist die Wirkung auf den Holzteil grösser als auf den Siebteil.
1.4. Die Anteilquote des Holzteils vergrössert sich im allgemeinen auf Kosten des Markparenchyms.
2. Von den Blattgeweben wird zunächst die Epidermis von der Spektralzusammensetzung des Lichtes beeinflusst.
2.1. Die Anzahl der Epidermiszellen und Stomata nimmt ab.
2.2. Die Zellen des Palisandenparenchyms sind stärker verlängert.
3. Auf die Gewebestruktur des Stengels wird eine grössere Wirkung ausgeübt als auf das Blatt.

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PROBLEMS OF CRETACEOUS-PALAEOGENE PALAEOPHYTOGEOGRAPHICAL REGIONS BASED ON PALYNOLOGICAL RESULTS II.

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Introduction

In our preceding work (M. KEDVES and EMŐKE KIRÁLY, 1968) we treated in details the Upper Cretaceous-Palaeogene palaeophytogeographical regions separable on the basis of geographical distribution of the angiospermal pollen grains. Relying to a larger extent on the spore-pollen data described from the Upper Cretaceous and Palaeogene sediments of the various palaeohpytogeographical regions in North America, we have compliled a stratigraphic table of the major sporomorphic types. Comparing this with that of Europe, interesting results have been obtained. Furthermore, we have dealt with the distribution of types considered to be significant from palaeophytogeographical point of view.

In this paper we endeavour to promote the solution of the problem with regard to the geographical distribution of the major types of the *Aquilapollenites* region on a world-wide scale.

Within the bounds of our limited means we considered all the relevant literature. The distribution of the form-species found in literary data is represented as genera or sub-genera. This work is raising several nomenclature problems. It is not the sole purpose of our work to do a taxonomic revision of the forms discussed for the examination material absolutely indispensable to carry out this task, is not available to us. Nevertheless, we think right, in order to avoid misunderstanding, to enumerate the genera under discussion and to mention the respective taxonomic problems. For the very first one we have the following suggestion.

Fgen.: *Wodehouseia* STANLEY 1961a.
Syn.: 1961 SAMOILOVICH. — *Kryshtofoviana*
1961 SAMOILOVICH. — *Regina*
1961 CHLONOVA. — *Deplexipollis*

1. *W. spinata* STANLEY 1961a
2. *W. fimbriata* STANLEY 1961a
3. *W. calvata* (CHLON. 1961) CHLON. 1962

3/a. *W. calvata* (CHLON. 1961) CHLON. 1962 var. *lindensis* SAMOILOVICH 1965

Note. — Our manuscript had been in press, when the publication of STANLEY 1970 (Bull. of the Georgia Academy of Science 28, 1—44) and that of KRUTZSCH 1970 (Pollen et Spores 12, 103—122) discussing the similar subject were published, thus we could not use their results in our work.

4. *W. oculata* (CHLON. 1961) CHLON. 1962
5. *W. gracile* (SAMOILOVICH 1961) SAMOILOVICH 1966
6. *W. jacutense* (SAMOILOVICH 1961) SAMOILOVICH 1966
7. *W. cirrifer* BRATZEVA 1965
8. *W. stanleyi* SRIVASTAVA 1966
9. *W.* fsp. A (BRATZEVA 1965)
10. *W.* fsp. B (BRATZEVA 1965)

Fgen.: *Azonia* SAMOILOVICH 1961

1. *A. recta* (BOLCHOVITINA 1959) SAMOILOVICH 1961
2. *A. fabacea* SAMOILOVICH 1961

Fgen.: *Jacutiana* SAMOILOVICH 1965

1. *J. hirsuta* SAMOILOVICH 1965

Fgen.: *Orbiculapollis* CHLONOVA 1961

1. *O. globosus* CHLON. 1961
2. *O. faber* CHLON. 1961
3. *O. lucidus* CHLON. 1961
4. Cf. *O.* fsp (SRIVASTAVA 1966)

Fgen.: *Expressipollis* CHLONOVA 1961

1. *E. ocliferus* CHLON. 1961
2. *E. cybaeus* CHLON. 1961
3. *E. accuratus* CHLON. 1961
4. *E. operosus* CHLON. 1961
5. *E. barbatus* CHLON. 1961
6. *E. ambagiosus* CHLON. 1961

As for nomenclature, the greatest problem was raised by genera *Aquilapollenites* ROUSE 1957, *Mancicorpus* MTCHEDLISHVILI 1961, *Integricorpus* MTCHEDLISHVILI 1961, *Projectoporites* MTCHEDLISHVILI 1961, *Tricerapollis* CHLONOVA 1961, *Fibulapollis* CHLONOVA 1961, *Parviprojectus* MTCHEDLISHVILI 1961, *Translucentipollis* CHLONOVA 1961. In studying the available literary data we consider probable that these genera have a morphological connection with one another. Therefore, we suggest to treat the subsequently enumerated genera as sub-genera under genus *Aquilapollenites*.

It is characteristic of the pollen grains of *Aquilapollenites (Aquilapollenites)* that the pole-axis and the „equatorial" axis are equal (Fig. 1). The *Aquilapollenites (Projectoporites)* type may easily be derived by the strong reduction of projections bearing pores. Consequently, the „equatorial" is surpassed by the pole-axis. From this *Aquilapollenites (Parviprojectus)* results whose symmetry is identical with that of the former but the projections bear no germinalia whose functions must have been taken over by certain growths on the poles.

In the same way, we can easily derive morphologically the *Aquilapollenites (Mancicorpus)* type from the *Aquilapollenites (Aquilapollenites)*. Here, the pollen become shorter in the direction of the pole-axis, only at one half. From this we may derive *Aquilapollenites (Fibulapollis)* by which the equato-

rial axis becomes longer and the typical „aquilapollenites germinalia" cannot be recognized. If attention is paid only to the changes in symmetry and the germinalia are left out of consideration then the latter pollen type is nearer to *Aquilapollenites (Aquilapollenites)* — and, in that case, the opposite symmetry-change in the morphological series *Aquilapollenites (Aquilapollenites)* — *Aquilapollenites (Projectoporites)* has taken place.

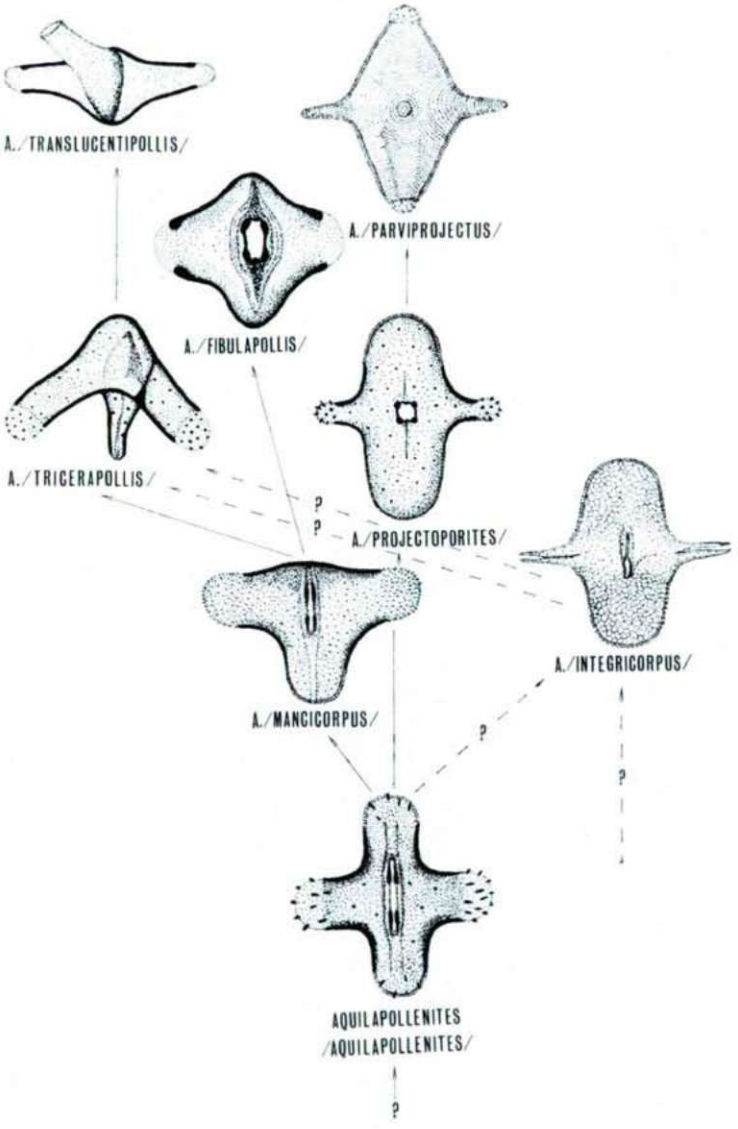

Fig. 1. Morphological series of the various sub-genera of *Aquilapollenites*.

Aquilapollenites (Integricorpus) may be derived, supposedly, from *Aquilapollenites (Aquilapollenites)*. Neither is it excluded, that it is the result of an independent series of development. In regard of its symmetry conditions, it is by and large identical with the *Aquilapollenites (Projectoporites)* type. At any rate, there are instead of the typical „aquilapollenites germinalia".

Aquilapollenites (Tricerapollis) is very interesting from this point of view, for as regards the symmetry conditions, it can be derived from *Aquilapollenites (Mancicorpus)* although the pollen is reduced to projections keeping the germinalia.

It is particularly interesting that of the two germinalia one is „Aquilapollenites" and other is „Integricorpus" in type.

The *Aquilapollenites (Translucentipollis)* type possibly derives from this especially when symmetry conditions are concerned. We must emphasize that the germinalia are similar to those of *Aquilapollenites (Fibulapollis)*.

On the basis of our suggested morphologic series we are led to the conclusion that the modern *Angiospermatophytic* pollen cannot possibly derived from either of the pollen grains mentioned. They must have been, therefore, the pollen grains of the ancient *Angiospermatophyta* that are long extinct.

The following species may be classified into the provisory sub-genera discussed above:

Aquilapollenites ROUSE 1957 *(Aquilapollenites)*

1. *A. (A) quadrilobus* ROUSE 1957
2. *A. (A) trialatus* ROUSE 1957
3. *A. (A) amplus* STANLEY 1961c
4. *A. (A) asper* MTCHEDLISHVILI 1961
5. *A. (A) attenuatus* FUNKHOUSER 1961
6. *A. (A) cruciformis* MTCHEDLISHVILI 1961
7. *A. (A) granulatus* MTCHEDLISHVILI 1961
8. *A. (A) insignis* MTCHEDLISHVILI 1961
9. *A. (A) latilobus* MTCHEDLISHVILI 1961
10. *A. (A) quadricretae* CHLONOVA 1961
11. *A. (A) spinulosus* FUNKHOUSER 1961
12. *A. (A) subtilis* MTCHEDLISHVILI 1961
13. *A. (A) unicus* CHLONOVA 1961
14. *A. (A) conatus* NORTON 1965
15. *A. (A) minimus* JARDINÉ–MAGLOIRE (BELSKY, BOLTENHAGEN and POTONIÉ 1965)
16. *A. (A) procerus* SAMOILOVICH 1965
17. *A. (A) rombicus* SAMOILOVICH 1965

Aquilapollenites ROUSE 1957 *(Projectoporites* MTCHEDLISHVILI 1961)

1. *A. (P) abscisus* CHLONOVA 1961
2. *A. (P) magnus* MTCHEDLISHVILI 1961
3. *A. (P) ovalis* MTCHEDLISHVILI 1961
4. *A. (P) spinulosus* MTCHEDLISCHVILI 1961
5. *A. (P) amurensis* BRATZEVA 1965
6. *A. (P) dolium* SAMOILOVICH 1965
7. *A. (P) reductus* NORTON 1965
8. *A. (P) funkhouseri* SRIVASTAVA 1966

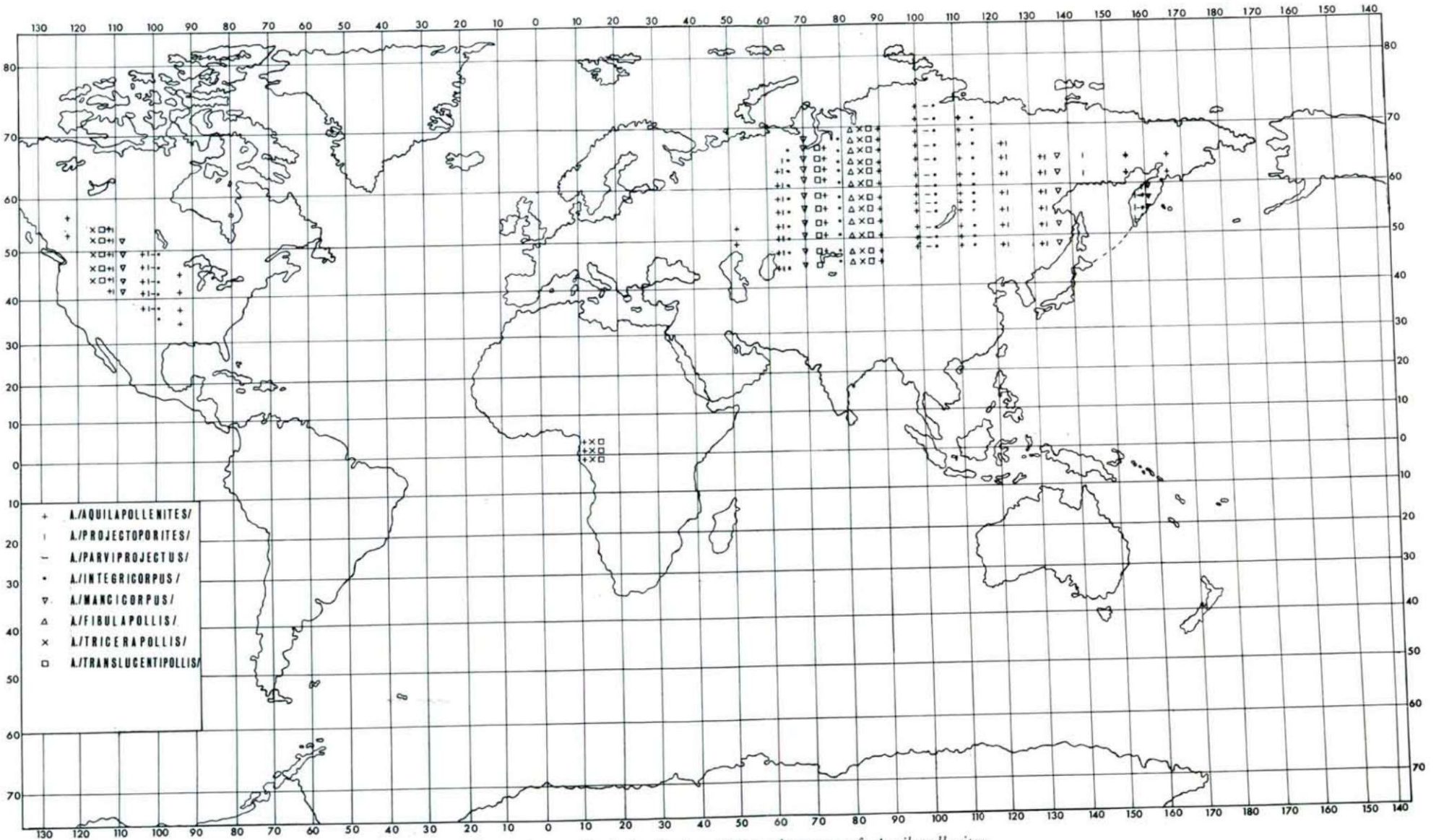

Fig. 2. Geographical distribution of the sub-genera of *Aquilapollenites*.

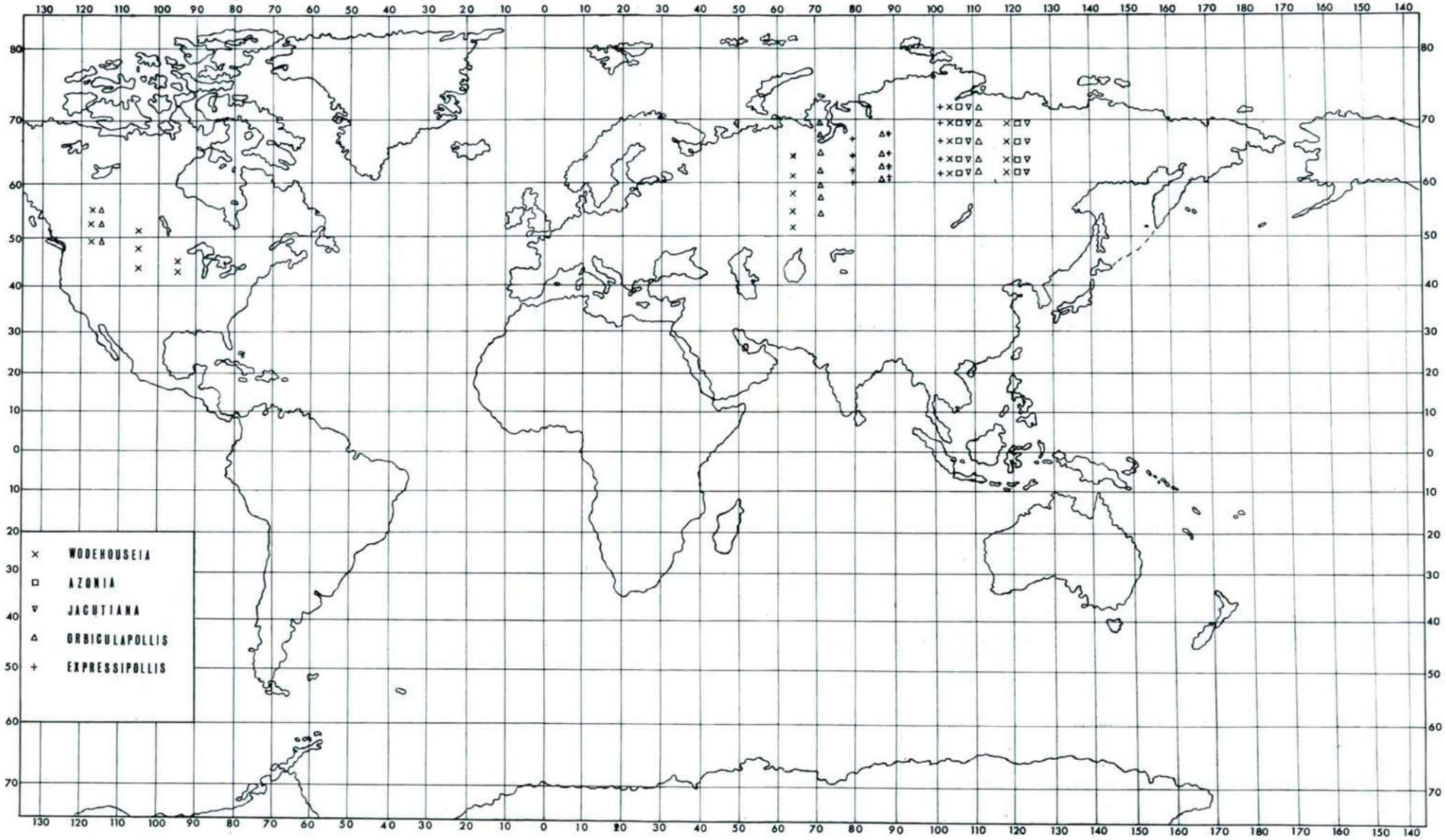

Fig. 3. Geographical distribution of the genera *Wodehouseia*.

sidered as very significant. On the other hand P. M. J. van HOEKEN-KLINKENBERG, according to her kind letter notice, has not found any *Aquilapollenites* in the Upper Cretaceous sediments in Nigeria. Similarly, T. van der HAMMEN reported that this genus is not yet known from the Upper Cretaceous and Lower Palaeogene sediments of South America. Therefore, its presence in equatorial Africa, is a local phenomenon, so far difficult to explain.

The idea my also present itself that there might have been a connection between the Upper Cretaceous florae in Central Siberia and equatorial Western Africa. To answer this question demands further investigations.

The types of the Aquilapollenites genus are particularly frequent in Central Siberia and their distribution is the largest there. It is worth while to consider the distribution of the single sub-genera in Siberia; which is as follows:

Sub-genera	Degree of Latitude	Degree of Longitude
A. (Aquilapollenites)	52°—166°	44° —73°
A. (Integricorpus)	66°—159°	44° —73°
A. (Projectoporites)	64°—157°	44° —73°
A. (Parviprojectus)	103°—158°	48° —73°
A. (Translucentipollis)	74°— 87°	44,5°—68°
A. (Mancicorpus)	70°—167°	45° —67,5°
A. (Tricerapollis)	85°	45° —69°
A. (Fibulapollis)	83°	45° —67,5°

These forms mass particularly in Central Siberia, in the territory between latitude 70—90 and longitude 44—70. As the number of the types is decrasing in eastern and south-western directions, the conclusion must be drawn that this territory one of the main centres of evolution of ancient *Angiosperms* in the Upper Cretaceous in the northern hemisphere.

The other one, the centre of *Normapolles,* might have been in Middle and Western Europe.

According to this concent the *Aquilapollenites* producting plants in North America have been derived from the Siberian centre by radiation. This is supported by the evidence that in North America there is no recent type in this group and that this genus is known there primarily from the Upper Cretaceous, Maestrichtian and the Lower Palaeocene sediments. On the other hand, mainly in Central Siberia, it was found in the lower levels of the Upper Cretaceous, as well.

The distribution of sub-genera *Aquilapollenites* in North America is as follows:

Sub-genera	Degree of Latitude	Degree of Longitude
A. (Aquilapollenites)	93°—123°	34°—57°
A. (Projectoporites)	102°—110°	42°—54°
A. (Tricerapollis)	117°	43°—54°
A. (Translucentipollis)	115°	43°—54°
A. (Mancicorpus)	108°	42°—52°
A. (Parviprojectus)	101°	38°—49°
A. (Integricorpus)	99°	36°—49°

It must further be noted in connection with the distribution in Siberia that toward east from latitude 90° their southern boundary is somewhat strifted towards north.

In North America and in Siberia the northernmost and southernmost presence of the genus, as known so far, is as follows:

	In North America	In Siberia
a) Northernmost boundary	57°	73°
b) Southernmost boundary	34°	44°

In the two continents a difference of 16° between the northern and 10° between the southern boundaries can be observed.

It should be emphasize that these differences may modify when further localities were found. We think, anyway that these results support the earlier suppositions concerning the shifting of poles.

In connection with the other examined genera — *Wodehouseia, Azonia, Jacutiana, Orbiculapollis,* and *Expressipollis* — further conclusions my be drawn:

For the time being, these genera are unknown from the southern hemisphere.

Their centre might have been in Siberia, more to the north-east than that of *Aquilapollenites,* most likely in the territory between latitude 100—125° and longitude 60—72°.

At latitude 64°, the difference between the southern boundaries of *Aquilapollenites* and *Wodehouseia* is 8° in Siberia, and at about at latitude 100° it is 14°. In this way, in Siberia, advancing in eastern direction, and compared to *Aquilapollenites,* the southern boundary of *Wodehouseia* and that of the genera examined in Fig. 3 is more and more shifted towards north while the northern boundaries are approximately the same. The displacement of distribution towards north took place with the genera mentioned above between latitude 70—80°, and in the case of *Aquilapollenites* between latitude 90—100°.

It is interesting and difficult to find an explanation why in the easternmost territory of the Soviet Union *Wodehouseia* and other genera described with it are not known, while in North America *Wodehouseia* could be found in several localities, and there are some data about genus *Orbiculapollis,* too.

The distribution of *Jacutiana* is local, for the time being.

In North America and Siberia, comparing first of all the northernmost and southernmost boundaries of *Wodehouseia,* we can establish that it is distributed more southerly in North America than in Siberia, its southern boundary reaches almost the southern boundary of the distribution of *Aquilapollenites* in Siberia.

Aquilapollenites is distributed in North America 9°, in Siberia 8° more to the south than the *Wodehouseia.*

The data concerning the above are summarized in the following tables:

Siberian distributions

Genera	Degree of Latitude	Degree of Longitude
Wodehouseia	64°—119°	52°—72°
Orbiculapollis	72°—112°	54°—72°
Expressipollis	79°—102°	60°—72°
Azonia	116°—121°	62°—72°
Jacutiana	118°—124°	62°—72°

North America distributions

Genera	Degree of Latitude	Degree of Longitude
Wodehouseia	94°—118°	43°—56°
Orbiculapollis	114°	49°—56°

In summing up, we can establish the following:

1. On the northern hemisphere we can distinguish two main centres of evolution for ancient *Angiosperms*. Partly the Middle and Western European *Normapolles* centre, partly the Central Siberian *Aquilapollenites* centre.

2. There are considerable differences between the southern boundaries of the Siberian and North American distributions of genus *Aquilapollenites*.

3. In Siberia, advancing eastwards, the distribution of genus *Aquilapollenites* is somewhat shifted toward the north.

4. Both in North America and Siberia, the southern boundary of genus *Wodehouseia* is more northerly than that of *Aquilapollenites*.

5. In Siberia, the northerly shifting of the southern boundary of genus *Aquilapollenites*.

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DRY WEIGHT AND CARBOHYDRATE CHANGES IN TOMATO SEEDLINGS GERMINATED IN DARK AND LIGHT

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Organic matter accumulation in seedlings has a great influence on the total life and its products in any varities of crops. As the tomato is day neutral plant it is interesting to examine the behaviour of organic matter accumulation of the seedlings, germinated in dark and light which may have corelation to the end products of this crops.

Mittal et al (1965) observed that tomato seeds germinate, both in light as well as in continious darkness, but the germination percentages was different under light regimes. When the seeds were continiously irradiated for 144 hours the germination was poor, as compared to the germinations in continious darkness.

Nutile et al (1950) are in the opinion that tomato seeds germinated equally well in darkness as well as when exposed to unfiltered light (white fluorescence) under laboratory conditions.

Mayer et al (1963) reported that the initial stages of germinations are consequently accompanied by a net loss of dry weight due to oxidation of substances on one hand and leakage out the seed on the other hand. In case of bean seeds the cotyledons show steady decrease in dry weight for the first four days of germination. At the same time similiar increase in dry weight can be observed in other parts of the seedlings and especially in the hypocotyl. They are also of the opinion that glucose and fructose rise very considerably up to six days of germinations and than begin to fall. Light does not only effect the absolute germination percentage but also the rate of germination.

Koller et al (1962) in an experiment reported that carbohydrate which are present in a form of storage material in many seeds are broken down during the early stages of germination, although somme external factors as well as inhibitors and stimulators effct carbohydrate breakdown to some extent, it seems likely that these effect are important only in so far as the breakdown products are utilized for respiration.

Materials and Methods

Variety „Kecskeméti konzerv" and „Kecskeméti törpe" was selected for the experiment. The seeds were properly placed in the petri-dishes with a equal number of one hundred, and soaked in Ion free water. Equal amount of water was added to each petri-

dish. Maintenance of temperature was equal in both cases of dark and light chambers at 22 and 28 degree centrigrade respectively. For light germination 12 hours light period was given in our light chambers (1965).

Proper care was taken by adding 1 ml. ion free water every day in case of light germinations, against drying up of seeds till the last date of germinations.

The seeds were said to be germinated when the radicle was emerged. The number of germinated seeds were counted and different parts were separated every day with utmost care untill the last and constant germination occured. Fresh weight was measured, then it was dried in oven untill the constant weight were achieved at 70° centrgrade. Dry weight was measured and carbohydrates were analysed (1956).

Results and discussions

In the dark „Kecskeméti törpe" shows quicker germination than „Kecskeméti konzerv" and intensity of germination was also more, (Fig. 1). Under light, intensity of germination is almost same up to seventh date, but in the eight day it is found to be lower, may be due to excess amount of exposure to light effect the germinations of last day (1965) but the absolute germination percentage was found to be same. (1963)

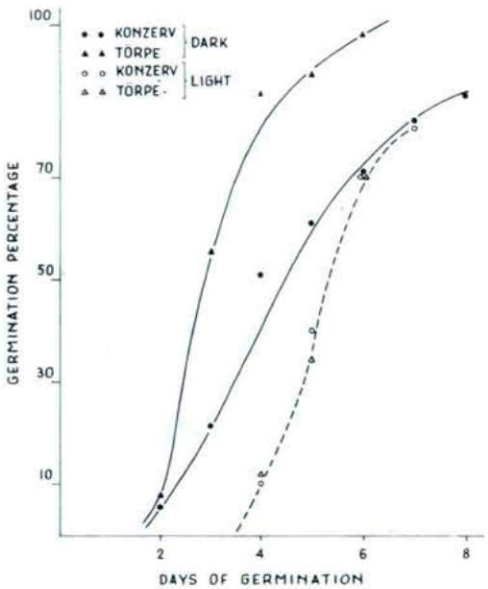

Figure 1. Germination percentage of tomato seeds under dark and light condition in different days.

From the Fig. 2—a, it can be noted that in dark there is practically no difference in dry weight between the radicle of this two variety. Both varieties show a rapid increase in dry weight. In light, variety „Törpe" shows more intensive increase in dry weight. For both varieties dry weight increase was more in light germinations.

In case of plumule (Fig. 2—b) the same phenomenon have been observed like in radicle in dark germinations, and in light there is no difference of dry weight increase between these two varieties. Dry weight was lower for both varieties germinated under light than germinated under dark. For both varieties germinated under dark and light there is no difference in dry weight decrease in cotyledon respectively (Fig. 2—c). After fifth day of germinations for both varieties decrease of dry weight was smaller in light germination than in dark.

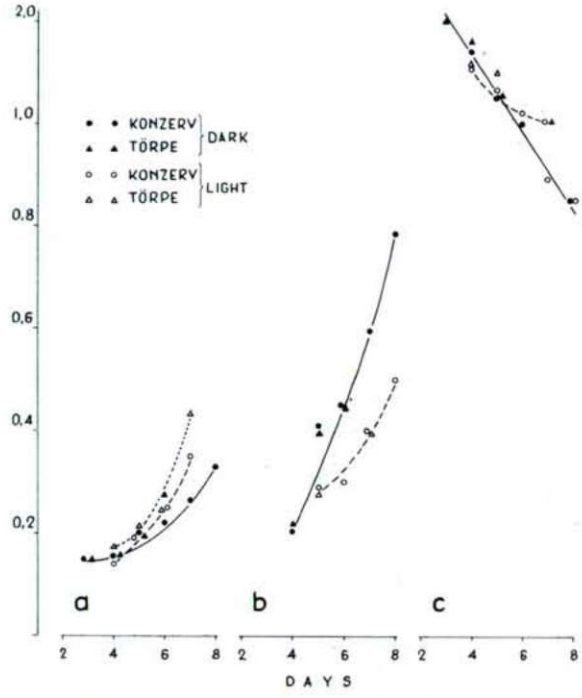

Figure 2. Dry weight changes of (a) Radicle, (b) Plumule, (c) Cotyledons of tomato seedlings grown under dark and light conditions.

In darkness (Fig. 3) variety „Törpe" shows more dry weight loss in comparision with variety „Konzerv". In light also variety „Törpe" shows dry weight loss, on the contray variety „Konzerv" shows constant gain of dry weight. The dry weight loss of variety „Törpe" in light and dark are almost same.

In dark and also in light (Fig. 4—a) the amount of carbohydrate increased in radicle is found and there are no difference between the two varieties. Light stimulates the carbohydrates accumulation of radicle in both varieties, but there are no difference in the plumule (Fig. 4—b) of both varieties neither in dark nor in light.

Both varieties has similiar trends of carbohydrate decreased in cotyledon (Fig. 4—c) and no difference was observed in dark and also in light. In light

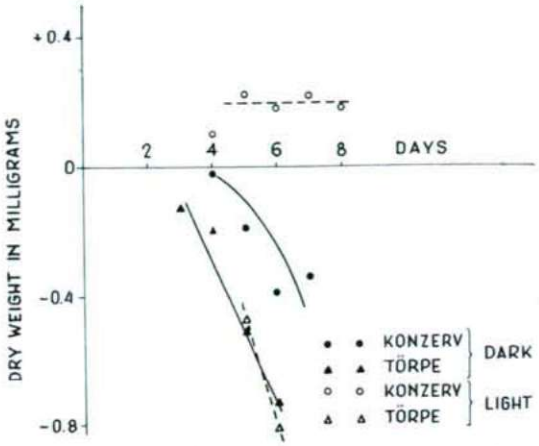

Figure 3. Dry weight loss and gain of tomato seedlings grown under dark and light.

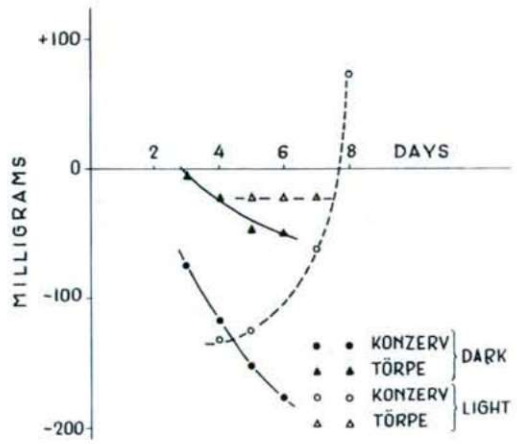

Figure 4. Carbohydrate changes of (a) Radicle, (b) Plumule, (c) cotyledon of tomato seedling in different days after germination under dark and lihgt.

after the fifth day, the carbohydrate decrease was lower than in darkness. Carbohydrate loss (Fig. 5) in variety „Konzerv" was higher both in dark and light except the eight day. After the fifth day the carbohydrate loss was similiar in light germinations than in dark.

It was observed that light enhance the dry weight increase in radicle, in higher degree in variety „Törpe" and also light inhibits the dry weight increase in plumule. The latter may be connected to the well known inhibition of light on elongation. After fifth day in light germination, the cotyledon dry weight deceases were smaller than the dark, which may be due to, besides respiration, photosynthesis also began and also the translocation to the plumule was decreased.

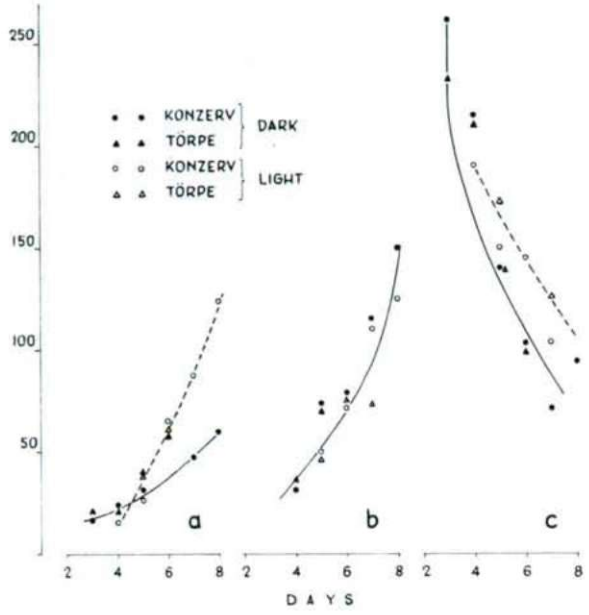

Figure 5. Carbohydrate loss and gain of tomato seedlings grown under dark and light condition.

The higher dryweight loss in „Törpe" in dark may be in connection with the more intensive germination and also may be due to intensive respiration, as the only source of energy of the process.

In light enhanced dry weight in the radicle of variety „Törpe" results no gain in dry weight while the variety „Konzerv" has constant gain of dry weight though the radicle weight was smaller. The variety „Törpe" which have probably more intensive respiration in light does not balance with the photosynthesis.

The carbohydrate changes in the radicle, plumule and in cotyledon are in accordance with the dry weight changes. In light, carbohydrate accumulation in new organs was stimulated by the beginning of photosynthesis while the carbohydrate translocation decrease in cotyledon was lower.

Variety „Törpe" which shows higher dry weight loss has a lower carbohydrate loss on the course of germinations, may be due to the respiration, of other than carbohydrates by this variety.

It is interersting to note that on eight day of germinations variety „Konzerv" shows carbohydrate increased, notwithstanding that there was dry weight increase of this variety beginning from the fifth day, which may be for the newly synthesized intermediary carbohydrate compounds were converted to nitrogen (protein) cell constituents.

Summary

The variety „Kecskeméti törpe" shows quicker germination in both in dark and light, as well as it has higher intensity of germination than the variety „Konzerv". Regarding dry weight there are practically no difference of dry weight for both varieties in dark. Variety „Törpe" shows more intensive increase in dry weight where both the varieties has an increasing tendency. Both varieties has shown similiar trends of carbohydrates decreas in cotyledon. The carbohydrate changes in the radicle, plumule and in cotyledon were in accordance with the dry weight changes.

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EFFECT OF THE COLD SOIL AND PHYSIOLOGICAL DRYNESS ON THE AMINO ACID METABOLISM OF WHEAT, BEANS SUNFLOWER, AND PAPRIKA

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Introduction

The physiological bases of the cold — and drought — resistance of plants are little known, as yet. It is already ascertained that the frost-resistance of cereals is connected with the degree of carbohydrate and free amino acid content of the plants (DÉVAY, 1962). From the work of KISS and POZSÁR (1968) it also appears that the increase of the free amino acid level is not a cause of cold-resistance but, owing to the repressed intensity of protein synthesis, as one of its immediate consequences.

Unfavourable external conditions lasting for several days (PÁLFI, 1965, 1968a) or contagious plant diseases (FARKAS, 1963; FARKAS and KIRÁLY, 1961) involve a decrease in the intensity of protein synthesis, and protein decomposition prevails. At that time a considerable amount of free amino acid, as well as glutamine and asparagine accumulate. The increased concentration of free amino acid and amide concentration here and there may be also a consequence of the abundance of nutrition supply (PÁLFI, 1965). According to FARKAS, (1968), an intensive protein synthesis is sometimes accompanied by a high „total amino acid level". It became necessary to look for a biochemical index on the basis of which a correct consequence can be drawn from the increased concentration of amide and amino acid.

In case of a lasting water deficiency the total amino acid and amide concentration of plants rises, as well (PÁLFI, 1968b). It has been supported by several experimental results that at the water deficit of plants the proline content of leaves is multiplied manifold as compared with the control of optimum water supply (BARNETT, 1966; PETINOV and BERKO, 1965; PROTSENKO et al., 1968; STEWART et al., 1966; SAVITSKAYA, 1965; VLASYUK et al., 1968).

In the course of our experiments carried out with twelve mono- and dicotyledonous species belonging to eight families (PÁLFI, 1968b, c) we demonstrated that the several hundred per cent increase of the proline content of leaves occurs exclusively as a consequence of water deficit. We have further ascertained, with culture pot and field investigations that this phenomenon manifests in every phase of development during the life of plants. According to our data, we may conclude the water deficiency of plants from the considerable increase of the proline concentration of leaves. On the basis of this fact, we demonstrated in several plants (PÁLFI and JUHÁSZ, 1968) that

a high total salt concentration of water that is present in soil in optimum quantity induces, by increasing the osmotic pressure of the medium, physiological dryness, and a water deficit in agricultural plants.

GOAS (1966) found the proline content of halophytic plants growing in a saline and strongly saline seaside soil as abnormally high. According to GOAS it is doubtless that high salt content of the medium brings about physiological dryness.

During our experiment we are getting on with investigating the influence of the high salt content of the root medium on the amino acid composition of plants. We would like to elucidate, as well, what kind of change is engendered in leaves and water balance of plants concerning the amino acid spectrum by a soil that is colder than optimum. The rising flow of materials produced in the roots and regulating the metabolism of shoots may cease to exist in the time of drought, as well as in isolated leaves. The extremely strong accumulation of proline takes supposedly place owing to the lack of a substance regulating the metabolism in the leaves. In case of isolated leaves, the root-hormone supply similarly comes to an end. It is questionable whether, or not, the great proline concentration appears also at isolated leaves kept in a water saturated state for several days.

We should like to establish, too, if proline accumulates also in the root system of plants as a consequence of its water deficit.

SVEDSKAYA and KRUZHILIN (1966) investigated the influence of cold on a lot of plant species and established that vernalization implies an accumulation of free proline. After cold treatment proline is used — according to them — for protein synthesis during germination as buds become differentiated. TRIONE et al. (1967) demonstrated, as well, a great proline accumulation owing to the cold effect of wheat vernalization. It is questionable if the proline accumulating effect of cold treatment takes only place in the time of germination.

TUMANOV and TRUNOVA (1967) studied the role of sugar accumulation and cooling down in respect of the winter wheat being weather-hardened against frost. According to their results, the fall in temperature itself is not enough for being hardened, also the plentiful supply of sugar to the cells is necessary. This fact is in connection with our experimental result (PÁLFI, 1968b; PÁLFI and JUHÁSZ, 1968) according to which proline accumulation in plants, as a result of water deficit, does not come from a protein but from carbohydrate decomposition.

Materials and Methods

We carried out experiments with wheat „Bezostaya 1", sunflower „from Kisvárda", beans „Black prince", and a red pepper (paprika) sort „57—13".

First we studied the amino acid spectrum of the leaves of plants durably cultured at optimum water supply and those suffering from water deficiency. Then we prepared irrigation-water, contining the salts of Na, K, Ca, Mg chloride and sulfate (van't HOFF's balanced solution with 2 p. c. total salt content and pH value 6, with a composition similar to the extract of saline solis). We already published the exact composition of van't Hoff's sodic salt solution (PÁLFI and JUHÁSZ, 1968).

The culture pots were filled with a mixture of sand and soil (2 : 1). We endeavoured to grow the plants under optimum conditions, in sunshine, from time to time irrigating them with KNOP's nutrient solution as well. The soil of the 30 day old sunflower was irrigated in every second day with running tap water and in the intervening days with van't HOFF's solution of 2 p. c. total salt content. The controls were irrigated, as before, every day with tap water. In this way, both varieties obtained daily the same amount of water. After salinating the medium for a fortnight, we retained leaf samples for analysis. For eight days the salt content of the soil was increased in the same way also in the media of 14-day old wheat, 21-day old beans, and for a fortnight in the medium of 50-day old paprika plants.

For cooling the soil, the paprika, sunflower, bean and wheat plants were grown till they reached the age of 50, 30, 21, and 14 days, respectively similarly in culture-pots filled with sandy soil but under artificial illumination (4000 Lux for 12 hours per day). Then the plants were removed with some soil and transplanted to a 12 cm high glass vessel of 7 cm in diameter. In the next two days the damaged plants were rejected. By that time the air temperature (24 °C) was taken over also by the medium in the pots. Then the pots of one of the varieties were placed into liquid coolant, cooled to 8 °C for 8 hours and incubated under this condition for three days (paprika, sunflower, beans). The root medium of the control remained at 24 °C. The wheat shoots remained on 16 °C and the root medium on 0 °C for four days. At the control plants both shoots and roots were on 16 °C. During the experiment, the soil of the cooled and non-cooled varieties were in the same humidity level (70 p. c. water content calculated for the full water capacity of the soil). In three or four days the plant leaves of were fixed.

The ethanol (50 p. c.) extracts of 200 mg of the leaves dehydrated and pulvenzed were developed on an ascending one and two- dimension paper (butanol-acetic acid-water; 2 to 1 to 1, and phenol-metanol-water; 3 to 1 to 1). The method has been described by SZALAI (1957) and also by us (PÁLFI, 1963) in details. At proline, the blue colour of isatin reaction was measured with spectrophotometer. In determining the total amino acid, the red colour of the copper-salt complex following ninhydrin was measured with the comparative standard mixture method (PÁLFI,1965).

Experimental results

It can be observed in Fig. 1 (stripes A and B) that, as a result of drought, and of water deficit, the total amino acid and amide content of leaves of the sunflower is considerably higher than in the control with optimum water supply. This amino acid picture is similar to the amino acid composition of infected, diseased plants (PÁLFI and DÉZSI, 1968). It is, however, essentially differing from it in respect of one index: the extremely high proline concentration. It is readily seen from Fig. 1. as well, that in case of applying a phenolic solvent fewer amino acid stains come apart but proline is present in the highest Rf-value.

In plants of lasting optimum water supply — particularly in monocotyledons — the normal proline quantity has been present only in traces throughout the analysis. For multiplying this proline quantity, no quick or high-degree water deficit is needed. A sevaral hundred per cent inctrease of proline concentration is brought about even by a small water deficiency when lasting for number of days, much earlier than the shoots and leaves obviously turn wilted.

In respect of the ion antagonism, the varieties irragated with a balanced van't HOFF's solution of an increased total salt content have considerably been backward in growth than plants irrigated with rainwater. A strong slight appeared for the control (irrigated with rainwater) as regard to size and thickness of leaves, and stems. It appears from Fig. 1 (stripes C and D) that

the amino acid picture of the leaves of plants grown in a medium made saline is similar to that of plants suffering from water deficiency. This similarity manifests not only in the greater total amino acid content but also in the greatly increased proline content.

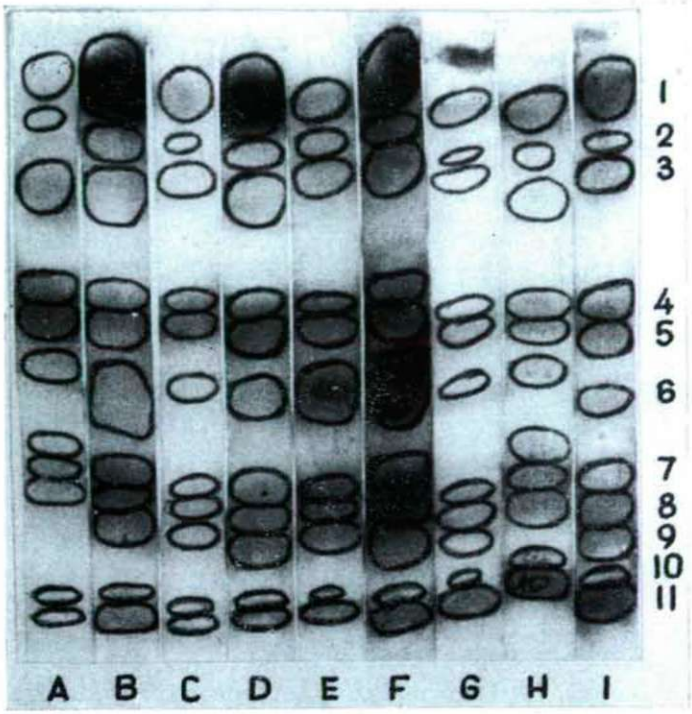

Fig. 1. Free amino acids of the leaves of sunflower plants suffering from water deficit and supplied with water. A = control, irrigated; B = not irrigated, water-dificient; C = control, irrigated with running tap water; D = irrigated with saline-sodic water; E = irrigated; shoots and roots on 24 °C; F = irrigated, shoots at 24, roots at 8 °C; G, H, I = comparative standard with 25, 50 and 100 μg total amino acid content. 1 = pro; 2 = Phe; 3 = Leu; 4 = Val+Met; 5 = γ-Amb; 6 = Glu—NH_2+Ala+Arg; 7 = Thr+Lys; 8 = Asp—NH_2+Gly; 9 = Glu+Ser; 10 = Cys; 11= Asp.

It is known that in the natural saline soils, too, Na-salts are dominant like in our van't HOFF's irrigating solution. In plants grown in these hind soils a large amount of Na^+-ions may accumulate, competing with other nutrient ions during uptake (PÁLFI, 1963). When measuring the Na-content of leaves with flamephotometer it appeared that the Na-concentration of leaves of the variety grown in a medium of increased salt content became 20 times higher than that of a control irrigated with tap water, what is in fact, a damaging factor (LAPINA, 1967).

In spring, in cereals often a major difference occurs between the temperatures of the root medium and of the air. Under such circumstances a dry

wind may quickly spring up that is relatively warm as compared to the temperature of soil. Thus, the transpiration of shoots increases and at the same time in the cold soil the vital functions of roots decrease.

Figure 1 is showing (stripes E and F) that an accumulation of amino acids and particularly of proline is engendered also by a temperature (8 °C) that is very low as compared with that of the air (24 °C) and lower than optimum; like in the case of water deficient plants (stripe B) or high salt content of the soil solution (stipe D).

In Fig. 2, we are demonstrating the amino acids of the leaves of paprika, sunflower, and bean plants the roots of which were cultured in a cooled (8 °C) or non- cooled (24 °C) soil and their shoots in an temperate (24 °C) air. The three stripes (C, E, and G) of the figure contain extremely large and dark stains, the same stripes which are containing the extracts of leaves of the plants cultured cooled soil. The total amino acid and proline concentration of the leaves of plants cultured cold soil is therefore considerably higher than

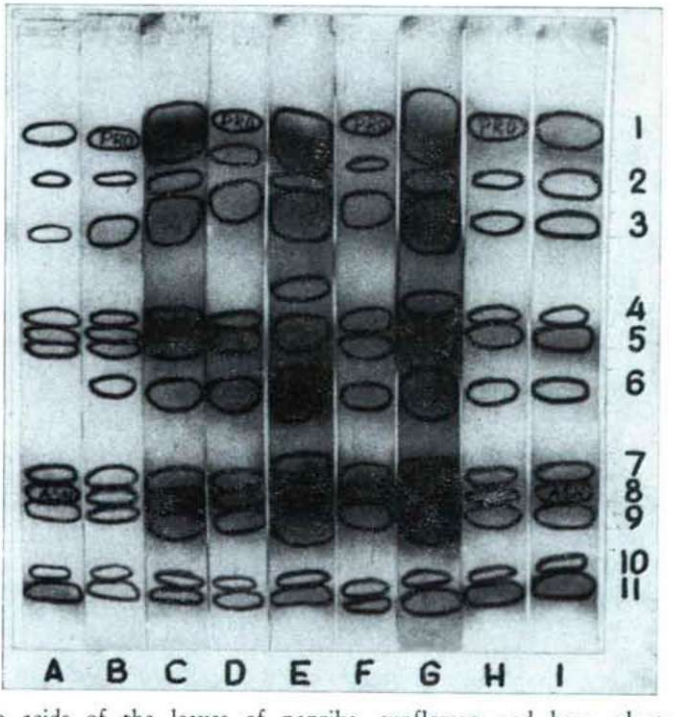

Fig. 2. Amino acids of the leaves of paprika, sunflower, and bean plants cultured in a cooled root medicum (8 °C) but in warm air (24 °C) controls plants cultured in warm air and warm root medium, at 24 °C. B = paprika, both root and shoot are warm (24 °C); C = paprika, the root at 8 °C, shoot at 24 °C; D = sunflower, both root and shoot are warm; E = sunflower, the root at 8 °C, shoot at 24 °C; F = beans, both root and shoot are warm; G = beans, root at 8 °C, shoot at 24 °C; A, H, I = comparative standard, proline is 2,5 and 5, resp. 10 μg. 1—11 = The same as in Fig. 1.

that of varieties cultured warm soil (stripes B, D, F). This phenomenon may be rather common for we have carried out our experiments on several species of cultured plants.

We performed our experiments with cooling the rootmedia of thermophilous plants germinated under comparatively high temperature. Now we turn to the results of our investigations in cooling concerning the winter wheat „Bezostaya 1", a comparatively cold-ressistant plant species. In what we cooled the root medium to a even lower temperature (0 °C) and the air temperature was lower (16 °C), too. We continued cooling for four days.

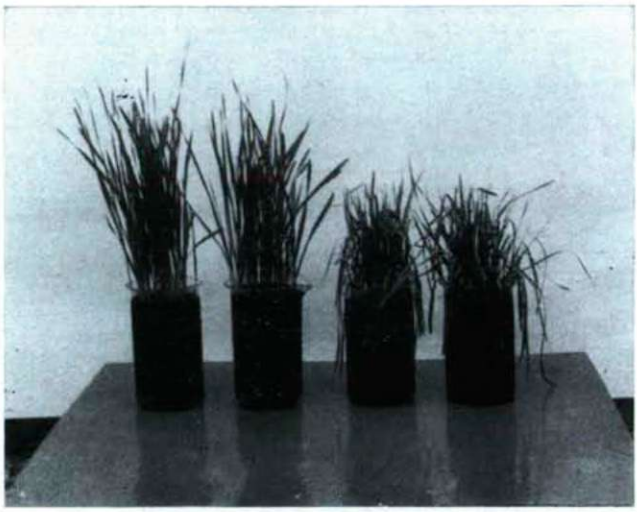

Fig. 3. Wilted wheat plants cultured in cold root medium (0 °C) but in warm air (16 °C) (on the riht) and control on the left — turgescent plants cultured in warm root medium and warm air.

Figure 3 demonstrates that the longer shoots cultured in cooled root medium have fully lost their turgor and bent down wilted. It is noticeable, that the water content both of the soil of 16° and that of 0 °C was equal. The cooled roots were, therefore, in capable supplying the shoots with water. The fresh weight of shoots of this variety was 32 p. c. smaller than that of the non-cooled variety. It is interesting that in the dry weight of shoots we have not found any difference between the two kinds of treatment. In quantity and dry weight of the roots however, a considerable difference appeared. The dry matter of the cooled roots was 22 p. c. smaller than that of the variety cultured warm. For comparison, the leaf extracts of wheat plants suffering from water deficit owing to drought and irrigated with water sendered saline, as well as those cultured in a cooled medium were put on the stripes of a chromatogram paper (Fig. 4).

It appears from Figure 4 that the shoots of plants containing an optimum quantity of water but cultured in a soil of high soluble total salt content

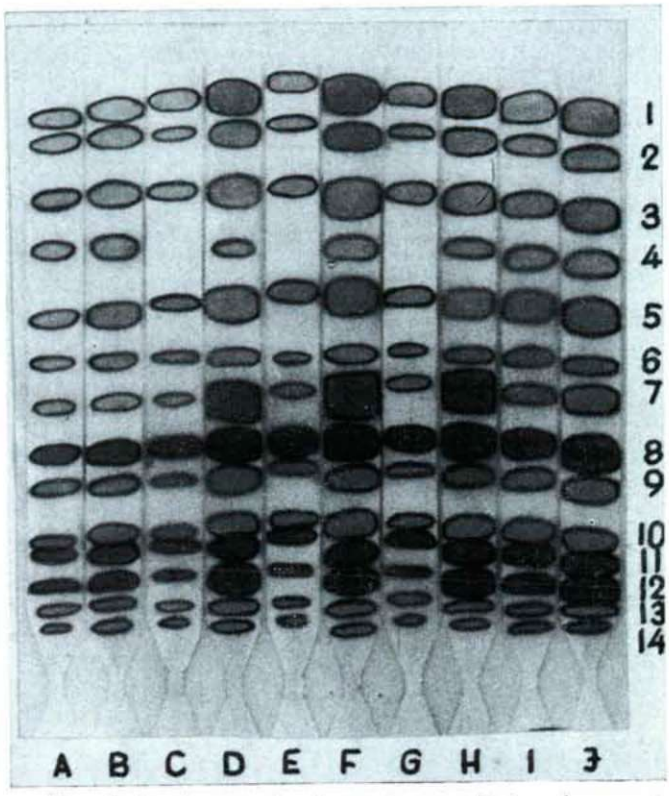

Fig. 4. Amino acids of the leaves of wheat plants suffering from water deficit and with optimum water supply. C = control, irrigated; D = not irrigated, water-deficient; E = control, irrigated with running tap water; F = irrigated with saline sodic water; G = both shoot and roots at 24 °C, irrigated; H = shoot at 16 °C, roots at 0 °C, irrigated; A, B, I, J = comparative standard, order of proline: 2,5, 5,0, 7,5 and 10 μg. 1 = Leu; 2 = Phe; 3 = Val+Met; 4 = pipecolic acid; 5 = γ—Amb; 6 = Tyr; 7 = Pro; 8 = Ala; 9 = Glu+Thr; 10 = Gly+Ser; 11 = Glu—NH_2+Ser; 12 = Asp—NH_2+Arg; 13 = Lys+His; 14 = Cys.

(stripe F) or of low temperature (stripe H) contain an extremely large quantity of proline (32 and 25 μg) just like the plants suffering from water deficit owing to the low water content of the soil (stripe D: 22 μg). The controls of the same plants (stripes C, E, and G), i. e. the leaves of plants cultured in a non-cooled soil, irrigated with the optimum quantity of water with small salt content are wqually containing a very low quantity of proline (2. 5 μg). In Figure 1, Table II, the amino acid stains of standards of a measured amount (stripes A, b, I, J) enable us to carry out a rough quantitative estimation.

We should also mention that the chromatogram of Fig. 4, was made, distinguishing is from the former ones, in a butanol solvent; its development

was slowed down by cooling. In case of tempering like this, though occurring rarely a non-protein forming amino acid, the pipecolic acid may appear as independent statins. It is appearent in Fig. 4. that, besides the standard stripes, also the leaves of varieties cultured under unfavourable external conditions (stripes D, F, and H) contain pipecolic acid. Pipecolic acid (PÁLFI, 1965, 1968a; PÁLFI and DÉZSI, 1968) is a sing of a weakened physiological state. It can generally be demonstrated only when in the leaves protein synthesis diminishes and protein decomposition prevails.

In the one-dimension chromatograms some amino acids do not come apart from other amino acids but form with them a common, complex stain. As in case of a two-dimension development a better separation can be obtained, to we which publish data, about wheat cultured in non-cooled and cooled media (Fig. 5). It should be mentioned that, as we have tried to get a clear picture about amino acids, we have prepared one- and two-dimension layer- and paper-chromatograms, too, in several repetitions from every extract of every investigated plant.

In Figure 5. becomes immediately obvious that the stains of amino acids are considerably larger in the chromatogram of wheat cultured in a cold root medium (O °C) than in the non-cooled variety. In the varieties cultured in low temperature very large glutamine and asparagine and particularly large proline stains are seen. In this variety pipecolic acid appeared, indicative of an intensive protein decompensation.

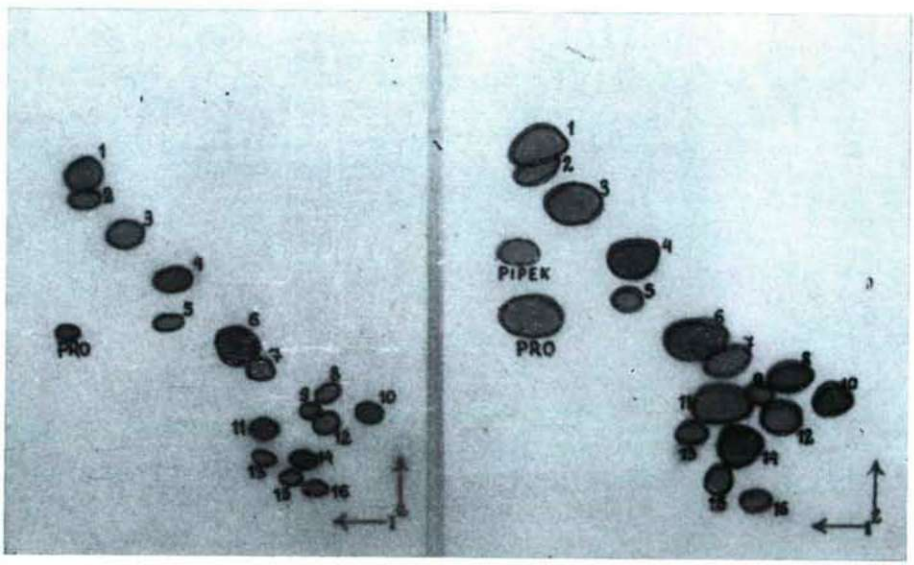

Fig. 5. Amino acids of the leaves of wheat plants cultured in a cold root medium (0 °C) but in warm air (16 °C) (on the right and their control) on the left — wheat plants cultured in warm root medium and warm air, i. e. at 16° C). Layer chromatogram. 1 = Leu; 2 = Phe; 3 = Val+Met; 4 = γ—Amb; 5 = Tyr; 6 = Ala; 7 = Thr; 8 = Glu; 9 = Gly; 10 = Asp; 11 = Glu—NH_2; 12 = Ser; 13 = Arg; 14 = Asp—NH_2; 15 = Lys; 16 = Cys.

In the following we are trying to elucidate whether the several prolines of isolated leaves really appear as a consequence of water deficit and not as a lack of the root factor regulating leaf metabolism. For that purpose we have had the sunflower and bean leaves excised in a water-saturated state for four days. During treatment the leaves were immersed in water twice a day for four-four hours, in the eight-eight hours intervals we incubated them under a wet filter-paper in big PETRI dishes under humid condition. In the meantime, during the immersions in water, and also for further six hours a day, they were illuminated.

Stripes B, C, D, and E of Fig. 6. demonstrate the free amino acid content of the isolated leaves of sunflower and beans cultured in a water-saturated

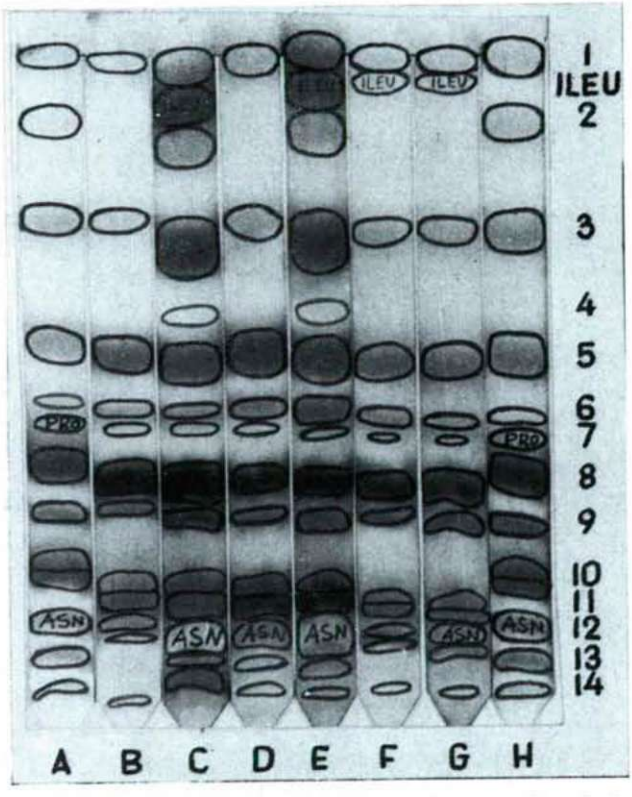

Fig. 6. Amino acids of isolated sunflower and bean leaves, cultured in water-saturated state for four days and the controls, as well as amino acids of the roots of irrigated and water-deficient wheat plants. B = sunflower leaves, immediately fixed after excision (control); C = sunflower leaves, incubated water-saturated for four days after excision; D = bean leaves, immediately fixed after excision (control); E = bean leaves, incubated water-saturated for four days after excision F = water-supplied (irrigated) wheat root; G = water-deficient wheat root (not irrigated); A, H = comparative standard, with 75 and 100 μg total amino acid content.

state for four days is considerably higher than that of leaves fixed immediately after excision. Isoleucine, phenylalanine, valine + metionine, and asparagine have particularly large stains. In the isolated leaves pipecolic acid has appeared, as well. The proline concentration of isolated leaves incubated for four days, is, however, quite low and does not surpass that of controls.

From Fig. 6 it is readily concieved that the proline content of the wheat root suffering from water deifcit (stripe G) is not higher than that of wheat with an optimum water supply (stripe F). It may also be established that the proline content of wheat root is very low.

Evaluation of results

Proline occurs among the free amino acids of the leaves of plants cultured under optimum conditions but in a very small amount. If, however, the plants have suffered from water deficit for two-three days, the proline content of leaves becomes a multiple of the normal amount. We already demonstrated (PÁLFI, 1968b; PÁLFI and JUHÁSZ, 1968) that the increase of many hundred per cent of the proline content of leaves is caused solely by water deficit. On the basis of our data, therefore, a conclusion can be drawn from the considerable increase in the proline concentration of leaves to the water deficit of plants.

The data obtained in the course of investigations carried out on sunflower, wheat, bean and paprika plants umanbiguosly demonstrate that the plants can suffer from water deficit even in case of an optimum amount of water in the soil with a high total salt content. The water deficit of plants cultured in a soil solution with high salt content was indicated by the extremely high proline concentration of leaves. It was proved, as well, that in the leaves of plants cultured saline medium the Na-amount increases twenty times as high as that of the control irrigated with tap water, what similarly causes damage (LAPINA, 1967; PÁLFI, 1963).

The proline may have, suggested also by other researchers (PROTSENKO et al., 1968; VLASYUK et al., 1968), in case of drought a role of increasing the hydration of protoplasm. In addition, it can serve as an auxiliary matter storing nitrogen, transformed into glutamic acid under favourable conditions (STEWART et al., 1966).

Water deficit may result too, if the roots of plant live in a soil of low temperature and its shoots in a streaming dry air of a considerably higher temperature. In the cold soil the activity of roots concerning water supply and transport decreases and the roots do not supply, water therefore, water deficit occurs because of strongly transpiring shoots. In our experiment we have endeavoured to clear up whether a physiological dryness like that is indicated, too, by the strong increase in proline concentration. It is proved by the results obtained on paprika, sunflower, bean and wheat that the proline concentration of leaves becomes manifold also as a result of water deficit caused by the low soil temperature. This water deficit may occur not only in the case, of a decreased water content of root medium but also when a proper quantity of the soil solution is available for the plants but, owing to their high osmotic pressure or very low temperature, they need a higher energy consumption (physiological dryness).

We have already demonstrated that in the case of water deficit the great amount of proline is not directly the issue of protein decomposition (PÁLFI, 1968c). It became known that the isolated leaves which are slowly wilting in darkness synthetize proline until their carbohydrate reserve is exhausted. After the sugars have been used up, the great amount of proline produced till then also decomposes before the leaves wither. By saccharose infiltration of cut off leaves wilting in darkness we have proved that the high quantity of proline in plants suffering from water deficit had been caused by sugar (PÁLFI, 1968c; PÁLFI and JUHÁSZ, 1968). In the leaves infiltrated with saccharose more proline, was formed and for a longer time than in the control leaves infiltrated by water.

For hardening the winter wheat against frost it is indipensable to supply the cells with plenty of sugar (DÉVAY, 1962; TUMANOV and TRUNOVA, 1967). At the same time, as it has been ascertained, if there is more sugar in the leaves, consequently, more proline is produced as a result of cold. From this connection it may be supposed that proline may also play a role in the frost-resistance.

During our experiment, the proline content of the isolated leaves incubated in light in a water-saturated state did not increase for four days as compared with that of the leaves fixed immediately after excision. These leaves are, of course, not wilted for no water deficit occurred. This fact proves that the high proline concentration of the excised, wilting leaves is not a result of a matter produced in the root — and transported under normal conditions to the shoot — for regulating metabolism but it was caused by water deficit.

We have investigated also the composition of amino acid in the roots of the water-deficient wheat, sunflower, paprika, and beans, ascertaining that, owing to water deficit, the amount of proline does not increase in the roots, therefore it is not transported from leaves to roots. A high degree synthesis of proline realizes only in organs containing chlorophyll. In this phenomenon, the formation of chlorophyll may have some indirect role.

DURANTON and MAILLE (1961) placed proline C^{14} in the leaves of *Solanum melongena* L. After six hours they demonstrated that 1 per cent of the absorbed proline was used up to the process of chlorophyll synthesis. The authors suppose a close connection exirting between the proline metabolism and the biosynthesis of the chlorophyll. We may also suppose that owing to drought the proline synthesis increases and the formation of chlorophyll ceases to function at the same time. COCUCCI and MARRE (1966) investigated aging isolated potato leaves. According to their data, sugars inhibited leaf dises from aging by slowing down the decomposition of chlorophyll and protein. The illumination of dises resulted also in the delaying of aging. The authors suppose that light exerts its effect through the products of the photosynthesis (partly through sugars).

Summary

We have established that the free amino acid and amide content of intact plants and isolated leaves suffering from water deficit increases in a considerable degree. This increase is a result of the stagnation of protein

synthesis. We generally obtain a similar picture for amino acid of infected or diseased plants. The water-dificient plants however, differ from the amino acid composition of diseased plants in an essential character: in the extremely high degree of proline concentration.

We have discovered that the enormous accumulation of proline in the leaves is not the consequence of a lacking root factor in regulating the metabolism of shoots. In case of a considerable water deficit of the plants the streaming of regulating substances from roots to shoots ceases to function. In excised leaves, kept in a water-saturated state for several days, the supply of root factor was though interrupted; never the less, the proline concentration remained on a normal level. We have established that from the raising of the proline content of leaves from the normal level to manifold the only reasonable conclusion is a water deficit of the leaves.

The water deficit of leaves is demonstrated by a considerable accumulation of proline, as an indicator, even if a sufficient amount of water is contained in the root medium, but its uptake by the roots is inhibited or rendered more difficult. Such physiological dryness was engendered by raising the salt content of the water used for irrigation. The considerable increase of the proline concentration in the leaves was already indicated in 2—3 days.

Water deficit developed also if the root system of the plants living in a soil containing an optimum amount of water but of a low temperature, and the shoots were in a dry air of a considerably higher temperature. It is proved by the data obtained in sunflower, paprika, bean, and wheat plants that the free proline concentration of leaves considerably increases also as a result of a physiological dryness like this.

We have ascertained that as a result of water deficit or physiological dryness in the roots of plants, the proline concentration is not superior to the root size of the plants of optimum water supply. A very high increase in the proline concentration, as a consequence of water deficit, occurs therefore, only in the parts of plants that contain chlorophill.

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EFFECT OF POST-EMERGENT HERBICIDE TREATMENT ON MONO- AND DICOTYLEDONS

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In our previous experiments, we applied preemergently (simultaneously with sowing) Diconirt, the sodium salt of 2,4-dichlorphenoxiacetic acid for mono- and dicotyledons (Lontai, Horváth, 1970; Horváth, Lontai, 1970). Monocotyledons are less sensitive to Diconirt than dicotyledons. Applied post-emergently (after shooting) in very high concentration (p. p. m. 666), it proved delatarious to growing and development of the seedlings of *Vicia faba* and *Pisum sativum*. The effect could be observed at cell-division, as well (Rojik, Horváth, Lontai, 1969). In this publication we are investigating its effect, applying it post-emergently and in different concentrations, on mono- and dicotyledons of the same age. From the point of view of selectivity, the form of the application of Diconirt is important because it does not penetrate into the tissues of plants in the same way.

Materials and Methods

We have chosen simple hybrid corn MV 530, sunflower „Iregi csikos (stripys Ireg)", and fodder-peas „IP_2" for experimental plants. The seeds were sown in culturevessels of 0,25 sq. m surface, into washed river sand, watered with Knopp's solution. The vessels were placed into an artificial plant-grower (Horváth, Lasztity, 1965). All the three plant species were sprayed on one occasion, seven days old, with a running tap water solution of various concentrations of Diconirt, the sodium salt of 2,4-dichlorphenoxiacetic acid. The next treatments, according to plant species, were: spraying with Diconirt of 0,25, 0,50, 1, 2, 4 per cent, and control. The plants treated and controls were watered with running tap water.

The experiments were repeated three times. On yellow corn we carried out a special experiment, as well, treating three-day old seedlings in the so-called nail-state in the described variations. The formation of fresh and dry weights, the amount of nitrogen and phosphorus were investigated 2, 4, 5, 10 days after treatment. Nitrogen was determined according to Nessler, phosphorus content according to Fiske—Subbarow (1925).

Discussion of experimental results

We have observed that the simple hybrid corn MV 530, as three-day old seedling in nail-state, tolerated spraying with Diconirt in a concentration applied by us. In the indices examined no difference was found.

The results of a series are presented in Table 1 after spraying seven-day old seedlings.

It appears from the table that, as compared with the control, the value of fresh and dry weights decreases after increasing the Diconirt concentration.

Table 1

Effect of Diconirt treatment on the formation of the fresh and dry weights of seven-day old simple hybrid corn MV 530, and on the formation of the total nitrogen and phosphorus content. (Calculation on γ/mg dry material) (Analysis four days after treatment)

	Control	Diconirt concentration in percentage				
		0.25	0,50	1	2	4
Fresh weight	4,392	2,750	3,100	2,620	3,020	1,660
Dry weight	0,410	0,300	0,308	0,265	0,293	0,239
Nitrogen	159	182	192	180	183	188
Phosphorus	41	34	30	48	36	31

Furthermore the water intake may gradually decrease after increasing the concentration, and in the same way growing and development also decrease.

As to the nitrogen and phosphorus content of the plants that suffered destruction in their growing, they did not show any difference, even four days after treatment, when compared to the control.

Diconirt in increasing concentration may have inhibited root activity and in this way also growing of shoots when seven days old.

The increase of N and P for 1 mg dry material is illusory for the gain in weight has decreased.

In Table 2 the result of a series of the sunflower „Iregi csikos" and of fodder-peas „IP_2" is shown.

Table 2

Effect of Diconirt treatment on the formation of the fresh and dry weights of sunflower „Iregi csikos" and seven day old fodder-peas „IP_2", and on the formation of the total nitrogen and phosphorus content. (Calculation γ/mg dry material) (Analysis ten days after treatment)

		Control	Diconirt concentration in percentage				
			0,25	0,50	1	2	4
Sunflower „Iregi csikos"	Fresh weight	7,410	5,780	5,620	4,910	5,185	2,450
	Dry weight	0,580	0,430	0,400	0,321	0,340	0,310
	Nitrogen	180	212	210	206	208	264
	Phosphorus	33	29	28	30	29	33
Fodder-peas „IP_2"	Fresh weight	4,150	3.180	3,720	3,300	2 010	2 630
	Dry weight	0,605	0,450	0,510	0,400	0,380	0,338
	Nitrogen	220	220	167	130	232	368
	Phosphorus	42	47	38	48	49	45

Both seven-day old plants were sprayed with the same concentration series as the yellow corn. The investigation took place ten days after the treatment. Here we have also observed a decrease in fresh and dry weights as a result of the treatment, when compared to the control.

In respect of nitrogen and phosphorus level, there was no difference to be found in the plants which suffered destruction.

On the basis of our data, peas responded to the Diconirt concentration more sensitively than the sunflower. The tissue structure has also some role at the post-emergent treatment of plants.

Summary

The sodium salt of 2,4-dichlorphenoxiacetic acid, in a concentration applied by us, had a greater influence on peas than on sunflower. Apart from the physiological differences, also the tissue structure of plants plays a role in the post-emergent treatments.

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ULTRASTRUCTURAL INVESTIGATIONS ON HUMAN CAROTID BODIES

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The carotid bodies are compact formations located in the carotid bifurcation. They can be found in the organism of all vertebrates except fish. Their histological patterns are by and large identical, their physiological role is, however, debated. To-day we consider them as chemoreceptors for perceiving the oxygen and carbon dioxid content of blood.

We have studied the structure of carotid bodies for more than 25 years, performing our investigations on human and animal material (hedgehog, dog, horse, pig, cattle, sheep). We used earlier stained and impregnated preparations, and light microscope for the investigations. We discuss below our findings on human material with electron microscope.

Materials and Methods

For the investigations we used human carotid bodies removed in an operative way owing to serious asthma bronchiale. The material was fixed immediately after the operation in 1 p. c. osmium tetraoxid bufferred according to Sorenson, dehydrated in a gradually increasing alcohol series and embedded in araldites. The sections and photographs were prepared partly in London, in the electron microscopic laboratory of the Middle Sex Hospital, Medical School, partly in Budapest in the Central Medical Research Institute, a third part in the Anatomical Institute in Budapest, and the forth part in Szeged, in the Institute of Zoology and Biology of the University.

From the structural elements found in the photographs we deal below with the glomic cells among them with chemoreceptor cells, capsel cells, and then we discuss our observations concerning blood vessels, nerve fibres and synapses.

Glomic cells

The glomerules that form the major part of the substance of carotid bodies and are delimited from one another with septa of connective tissue, consist in most part of glomic cells, blood vessels and nerve fibres.

Among glomic cells we could distinguish two types of cells. One of them is the chemoreceptor cell, the other is the capsel cell. The former ones are comparatively large, roundish cells having no or but a few processes which are rounded off at the end. The capsel cells are prolongated, bearing many processes that are long and surround the bodies resp. processes of the chemoreceptor cells like a cover.

Chemoreceptor cells

The cell membrane is delimited sharply, the cytoplasm is granulated, with a lot of granules and vesicles of various sizes. Among the granules there are major roundish, sometimes ovoid ones. These are the osmiophil bodies to be discussed later. There are much rarer the similarly roundish, large-sized lipoid bodies, covered by strongly osmiophile caps. It isn't infrequent if two pale lipoid bodies are connected together by an osmiophile cortex. The vesicles can be observed in the cytoplasm in very large masses, generally of uniform size but the thickness of walls shows considerable differences. Among the vesicles the cell organs take place from the following are to be observed clearly: 1) endoplasmic reticulum, 2) GOLGI complex, 3) mitochondria, 4) osmiophile bodies, 5) lysosomes, 6) cilia, 7) microvilli. Like characteristic cell formations, the desmosomes appearing here and there join those enumerated above (Fig. 1).

1) The endoplasmic reticulum consists of essentially straight parallel canals with proportionately wide lumen that appears mainly in the prolongations of the cells and also here at the basis in a conspicuous form. Sometimes they form a complicated canal system with wide lumen extending to the whole cytoplasm, some parts of them being meanwhile widened vesicle-like.

2) The GOLGI complex consists of a system of long, welldeveloped canals and of vesicles that can be observed in the form of characteristic fields near the nuclear membrane. The greater part of canals is parallel with the nuclear membrane.

3) The mitochondria are roundish, here and there elongated bodies all of them being constructed according to the crista type. There are frequent the typical dumb-bell-like shapes, their club-like terminal pieces are connected with a thin link. These forms bear reference to mitochondria multiplying by division.

4) The osmiophile bodies or „dense cored" vesicles are characteristic components of the chemoreceptor cells. Essentially they are dark, roundish bodies surrounded by a thin light cortex. According to the investigations in other fields they contain catecholeamin. It is strong phenomenon waiting for interpretation that where there are a lot of osmiophile bodies the mitochondria are few in number and vice versa, where there are a lot of mitochondria there are but a few osmiophile bodies.

5) The lysosomes are polymorphous, sometimes lamelliform dark bodies appear in the chemoreceptor cells here and there in large numbers. They can be seen in particularly great quantities and in large fields if the substance gets into the osmium acidic fixing bath later, after having been prefixed in formaline. Their mass appearance is connected with reducing processes in the cells (Fig. 2).

6) Cilia can be found in a comparatively low number but there are places where they are present in great quantities. In material of animal origin cilia had been found by other researchers as well (BISCOE and STEHBENS, 1966; HESS, 1968). These cilia are constructed, according to literary data as to follow type 9 + 0. These cilia shapes are qualified by some researchers as sensory cilia. The cilia observed by us belong to the type 9 + 2 being, therefore, small motorial organs. Their exact place could not be established, so far, their physiological role is unknown (Fig. 3).

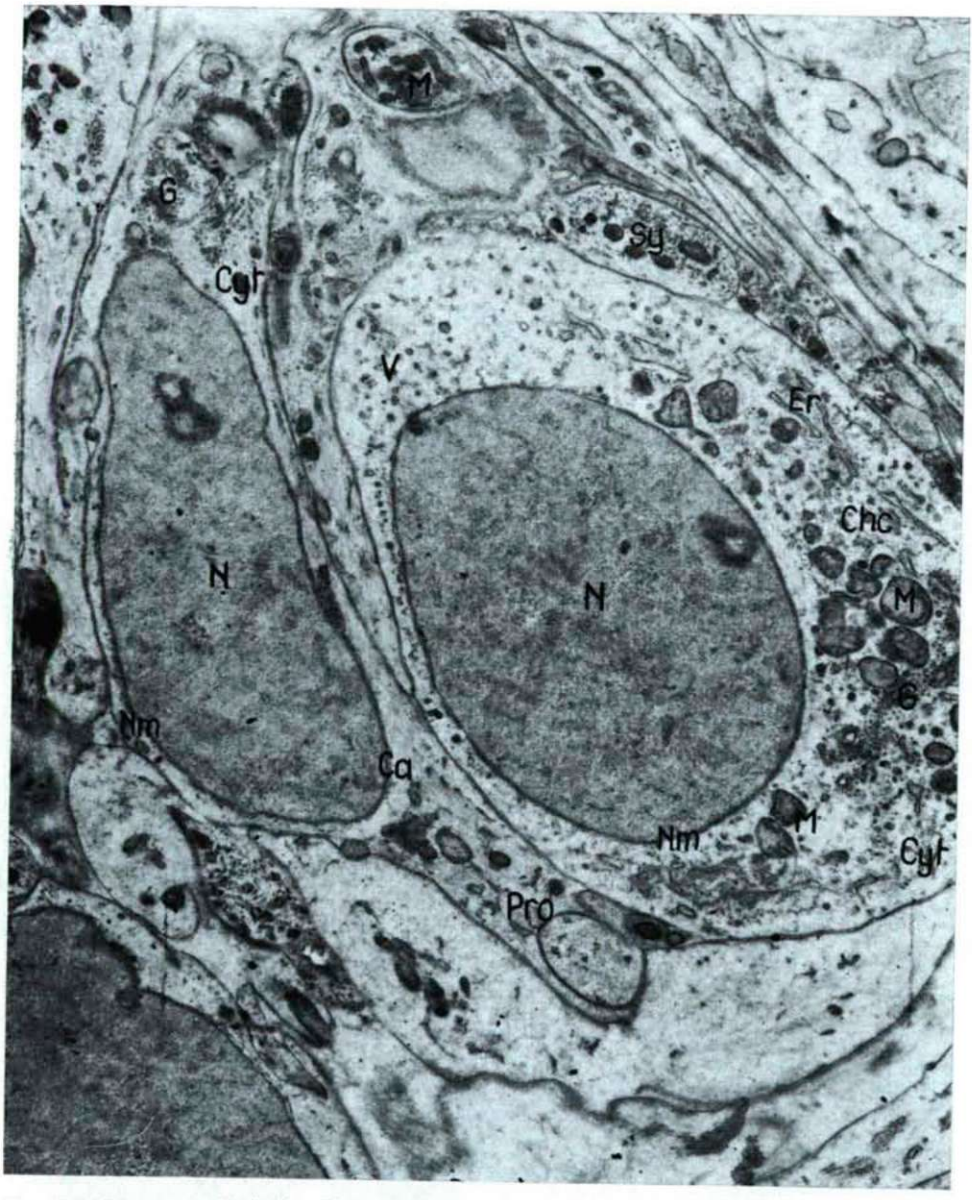
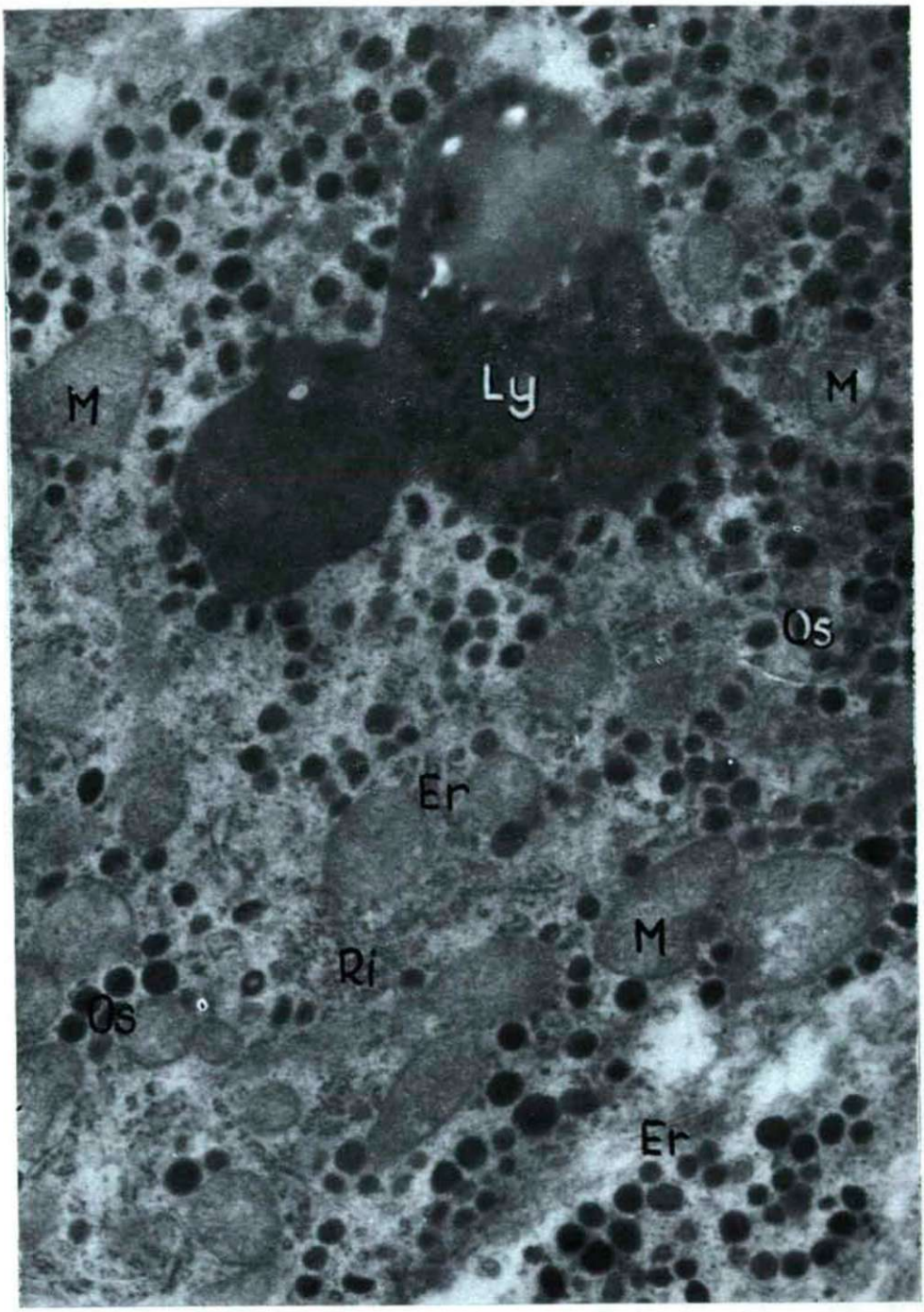


Fig. 1. Homo: carotid body. Chc — chemoreceptor cell, Ca — capsel cell, Cyt — cytoplasm, Er — endoplasmic reticulum, G — Golgi complex, M — mitochondrium, V — vesicles, N — nucleus, Nm — nuclear membrane, Pro — cell process, Sy — synapsis. x 25 000.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7) The microvilli are longer or shorter bulges of the surface. Their shapes are various, their thickness is even. The basis is sometimes wide, containing vesicles of various shapes and sizes.

The desmosomes are the „electron dense" parts on the cell membranes touching each other that considerably differ from one an other both in their length and in depth. They are similar to the synaptic membranes and the intercalated discs.

The nuclei of chemoreceptor cells are roundish and considerably large. The „indentations" of nuclear membrane are frequent, protruding here and there deep into the nuclear substance. The nuclear membrane consists of two lamellae separated from each other by a considerable space. The external lamellae often protrudes deep into the cytoplasm forming and extensive hernia (Fig. 4).

The nuclear pores are wide, round them systems of small granula take place that remind us of the closing structure of the excretory system of *Ciliata*. The granular elliptical systems may play also here a closing role. The nuclear pores, where they appear in larger areas, remind us of plant stomata (Fig. 5).

Capsel cells

The capsel cells are elongated, their nuclei are homogeneous and ellipsoid. The nucleus is surrounded by cytoplasm in the form of a narrow border. The capsel cells can be observed in a larger mass at the edge of glomeruli. They are similar to SCHWANN cells and even there is a possibility that they are simple SCHWANN cells (Fig. 1). This idea arises first of all if we think on the connection of capsel cells with the nerve fibres.

The capsel cells contain, namely, just as SCHWANN cells many neuraxons limited with a mesaxon membrane. The difference between the two cell forms lies in the fact that the SCHWANN cells have double-folded membranes and their connection with the neuraxons is richer than that of the capsel cells (Fig. 6).

Blood vessels

A particular feature of the vascular system is that the adventitia of the minor arteries and veins there are pressoreceptors provided with wide neurofibrillary endplates from which it follows that the carotid bodies participate, apart from chemoreception, in baroreception too.

The greater part of the vessels are sinusoid and capillaries the diameter of which is extremely variable highly dependent upon the prevailing physiological state. In case of the diseases in the area of cardiovascular system, they are dilating strongly. Under normal conditions from the lumen canals protrude between the cells. Their lumens have different diameters. By these canals it becomes possible that when need arises the vessel lumen can be

Fig. 2. Homo: carotid body. Chemoreceptor cell. Er — endoplasmic reticulum, Os — osmiophile body, Ri — ribosomes, Ly — lysosome, M — mitochondrium. x 75 000.

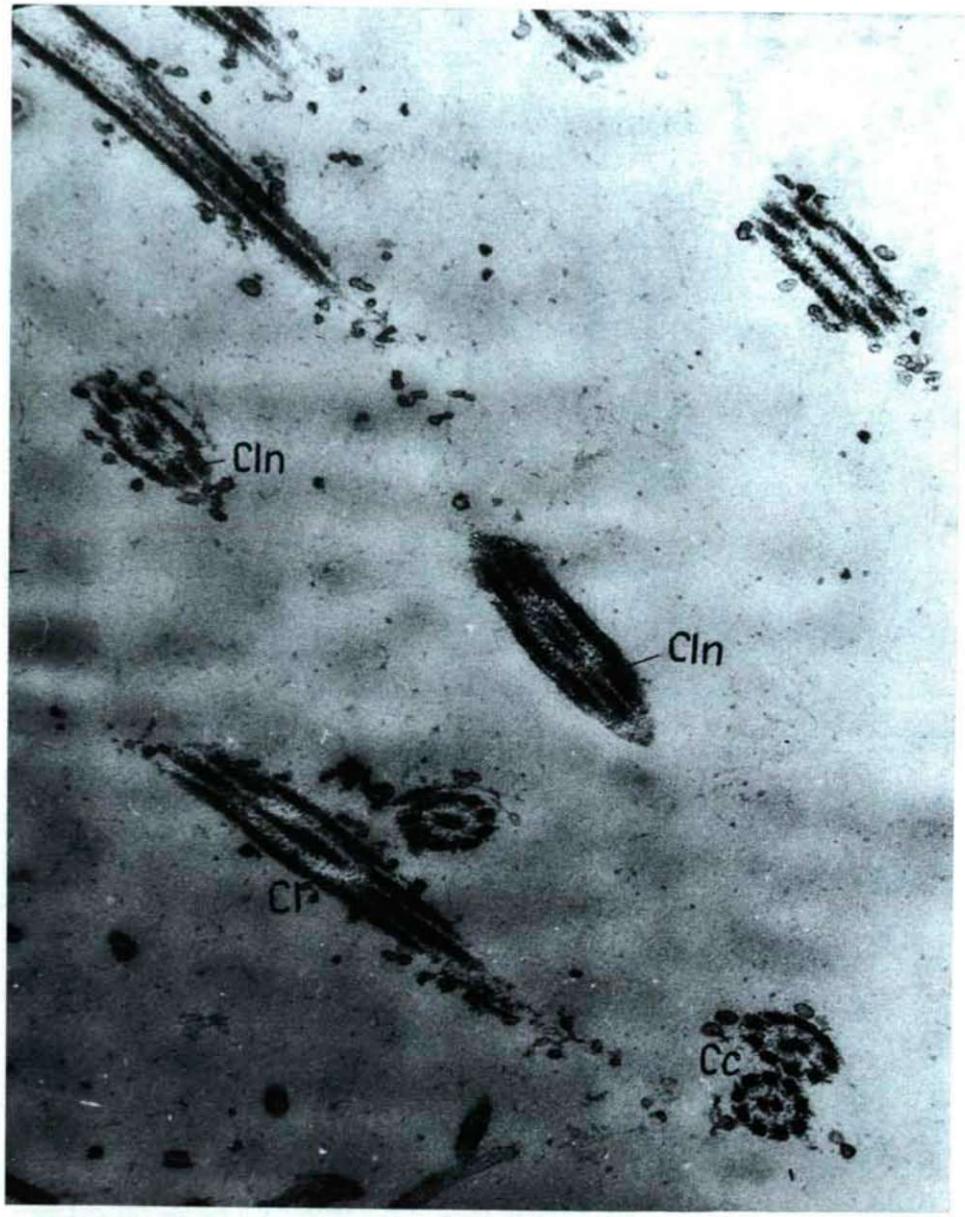

Fig. 3. Homo: carotid body. Cilia. Cc — cilium in cross-section, Cl — cilium in long-section, Cln — column. x 72 000.

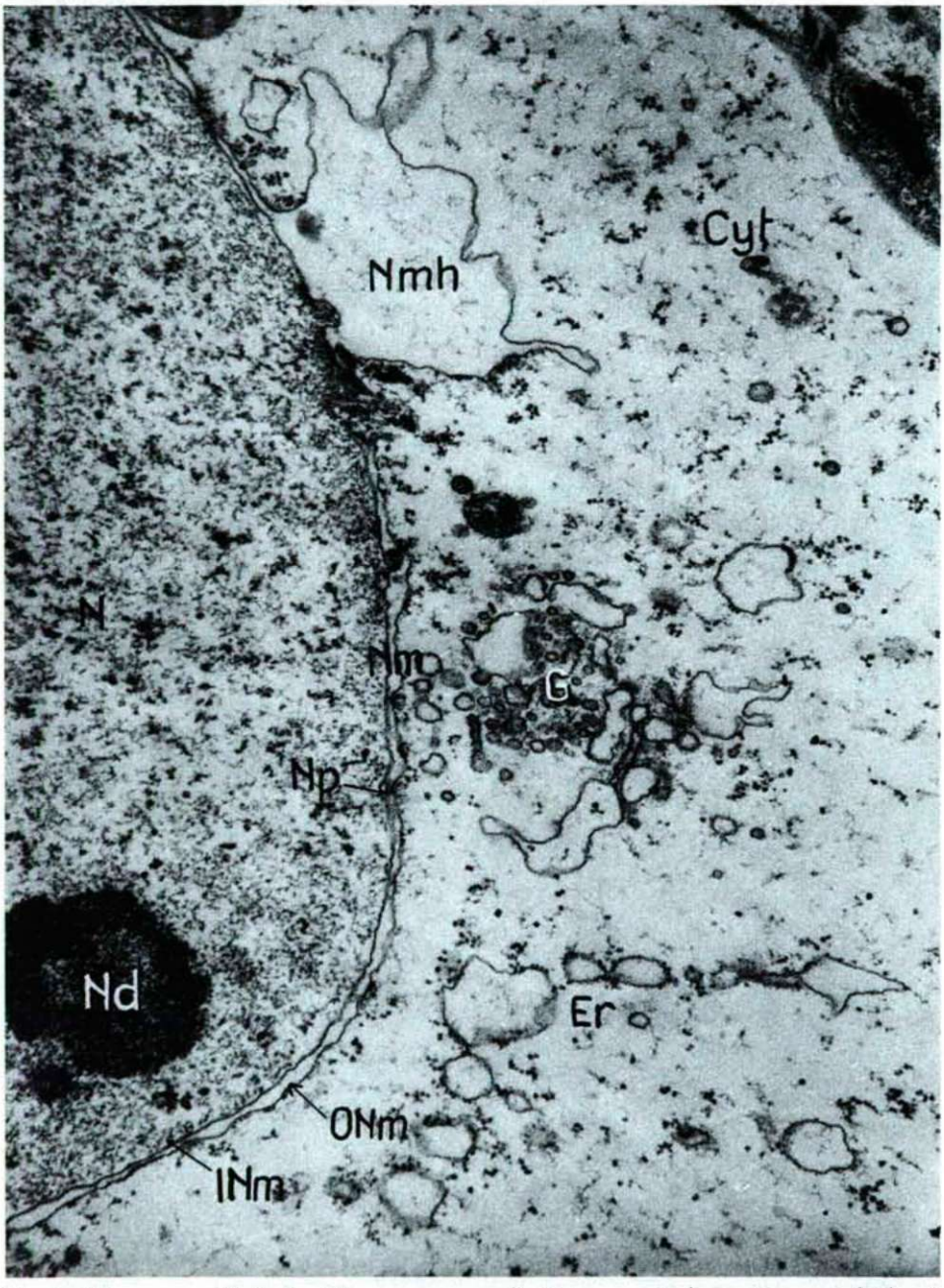

Fig. 4. Homo: carotid body. Chemoreceptor cell. Cyt — cytoplasm, Er — endoplasmic reticulum, G — Golgi complex, N — nucleus, Nd — nucleolus, Nm — nuclear membrane, ONm — outher nuclear membrane, INm — inner nuclear membrane, Nmh — nuclear membrane hernia. x. 56 000.

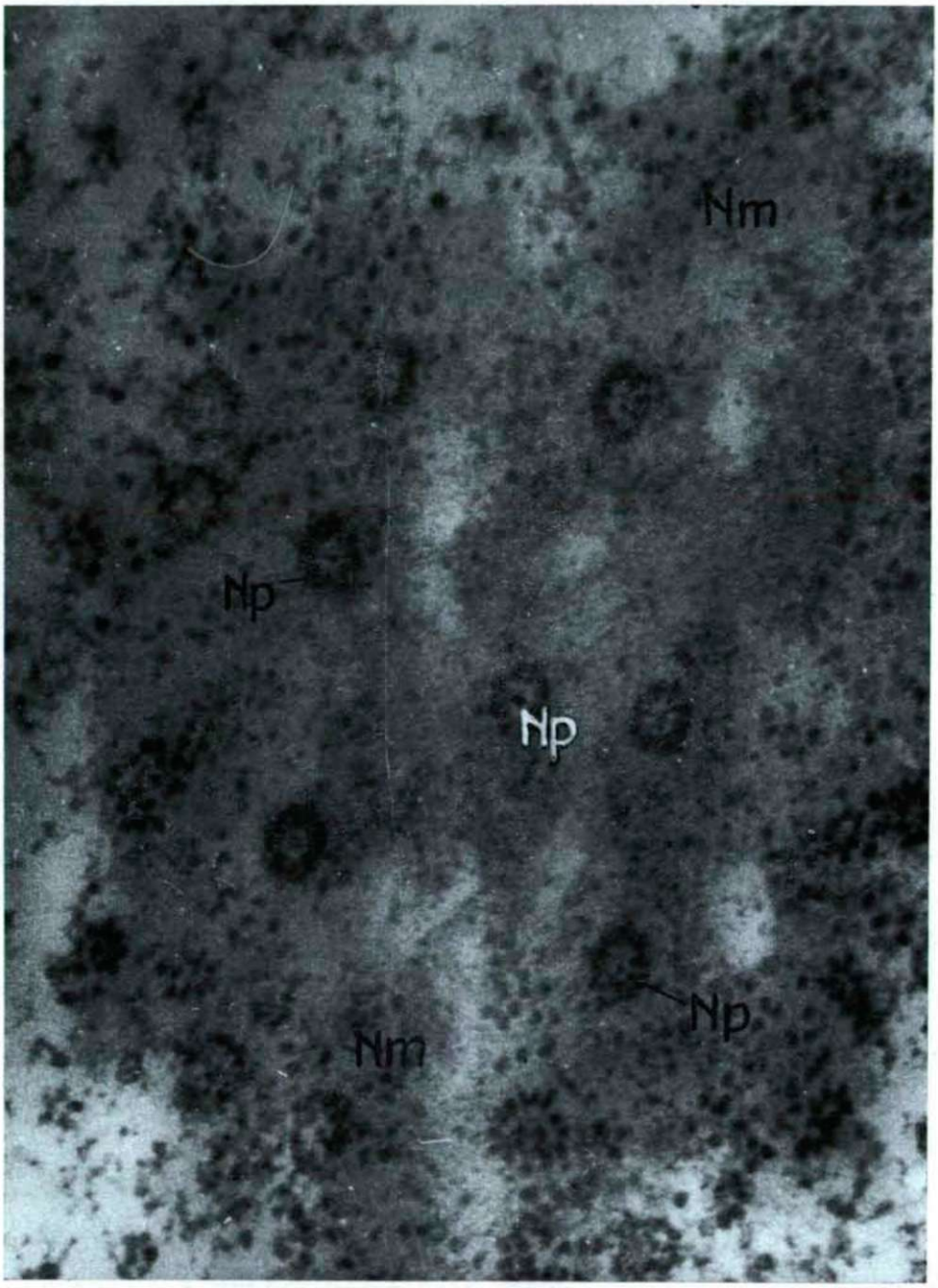

Fig. 5. Homo: carotid body. Chemoreceptor cell. Nuclear pores. Nm — nuclear membrane, Np — pores. x 92 000.

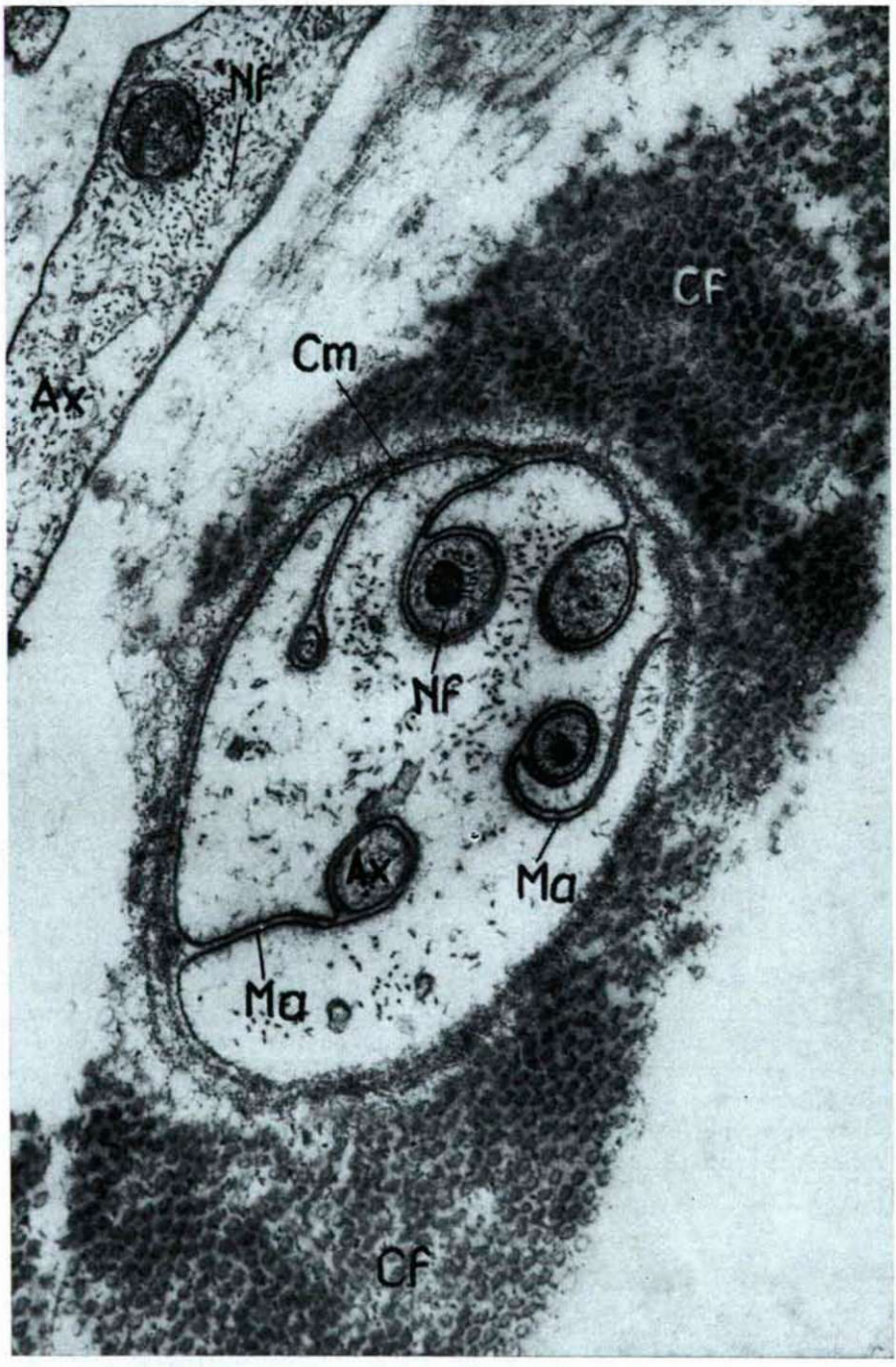

Fig. 6. Homo: carotid body. Schwann cell. Cm — cell membrane, Ax — axon, Ma — mesaxon, Nf — neurofilament, Cf — collagen fibrils. x 36 000.

extremely enlarged. Both the lumens of sinusoid vessels and those of the capillaries are limited by an uninterrupted endothelial cell layer. Then comes the basal membrane that consist of collagenous fibril boundles surrounded by a layer of pericytes (Fig. 7).

The endothelial cells are elongated, their shape is changing and depends upon the saturated state of the lumen. Some of them are brick-like others come up to blunt processes at both ends. The boundary between the cells is sharp. The adjacent cells are connected together with thick desmosomes of wavy course. The cytoplasm is homogenous but smaller or larger granules and vesicles are not seldom contained in them. The characteristic components of the cells are the microvilli at their radical parts with vesicles and here and there with intrusions sitting on a wide basis.

The collagenous fibrils of the basic membrane form a network with large meshes between the endothelium and the pericytes. The latter ones are narrow, elongated cells. Their cell membrane is not sharp, the cytoplasm and nucleus are highly homogenous.

The supposition represented by MARCHAND and later on by F. DE CASTRO, according to which, the wall of capillaries consisting here and there of parenchym cells, is not verified by electron microscopic pictures.

Nervous system

The carotid bodies are supplied abundantly with nerve fibres. The fibres are coming in trunks and bundles of different thickness from the glossopharyngeal nerve, vagus nerve and the ganglion cervicale supremunm. The fibre bundles belonging to different systems form a plexus rich in connective tissue capsule. This is named periglandular plexus. This denomination is attached to F. DE CASTRO's name, dating back to a time when the carotid bodies were thought to have an endocrine function. The plexus coming from the periglandular plexus surrounds the nests consisting of glomus cells. Therefore, it is called peri lomerular plexus. The third plexus is departing from the periglomerular plexus, penetrates inside the glomerule and surrounds the glomus cells with a lense fibre system. The name of this plexus is intraglomerular plexus.

In the sections, impregnated with our recently elaborated method (ÁBRAHÁM, 1968), there appeared sharply not only the various neuroplexuses but also endings were to be observed in large numbers in the form of end rings (Fig. 8). Their number being extremely high, we may draw with reason the conclusion that each of the glomus cells has its own nerve termination and even it is shown by the most pictures obtained, that a glomus cell must be connected with more nerve fibres (ÁBRAHÁM, 1968).

Synapses

All research workers who investigated the carotid bodies with electron microscope (ROSS, 1959; LEVER, LEWIS and BOYD, 1959; DE KOCK and DUNN, 1964; BISCOE and STEHBENS, 1965; GRIMLEY and GLENNER, 1967; HESS, 1968; DE KOCK and DUNN, 1966, 1968; DEARNALEY, FILLENZ and WOODS, 1968;

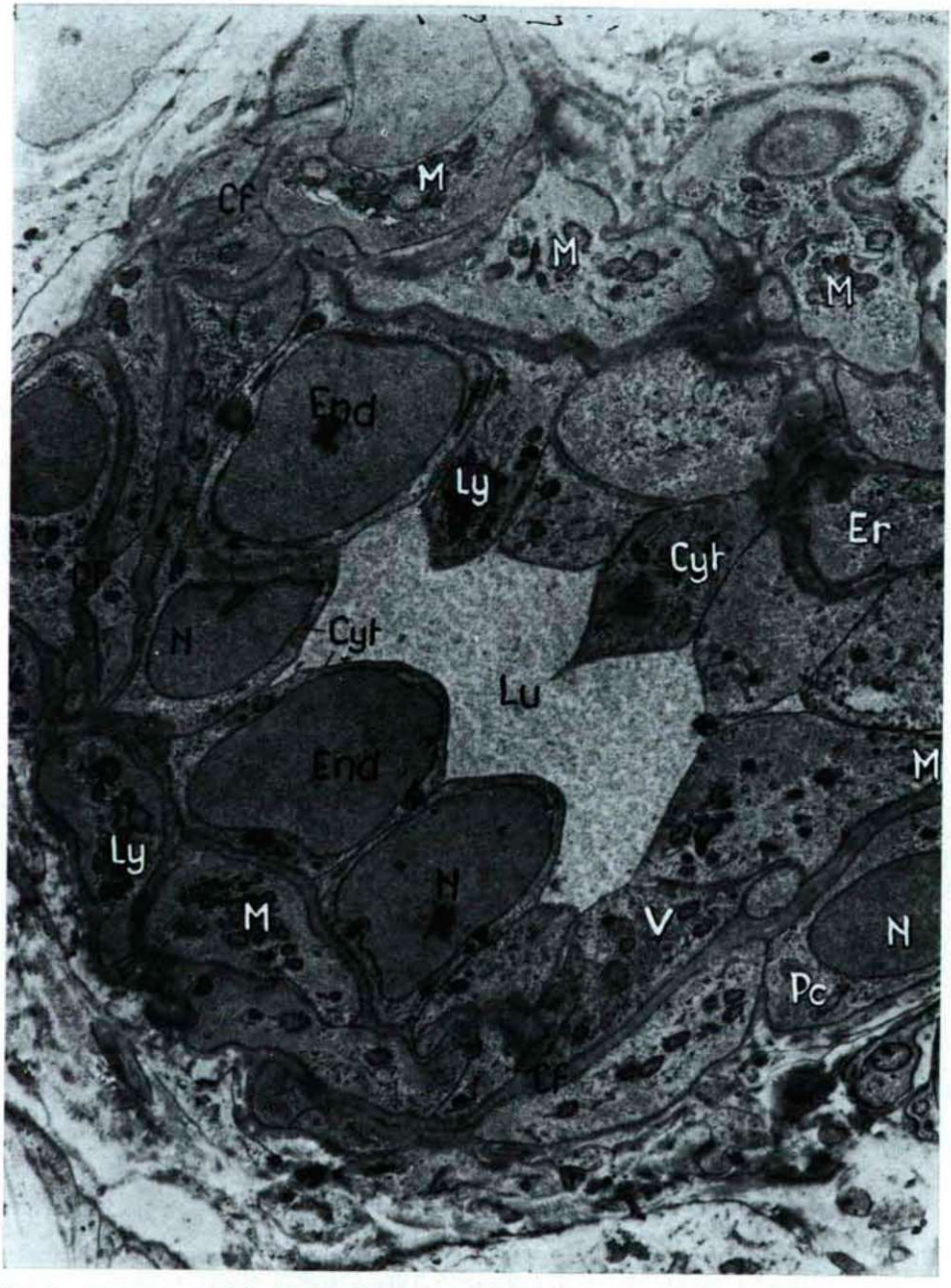

Fig. 7. Homo: carotid body. Capillary. Lu — lumen, End — endothel cell, Pc — pericyte, Cyt — cytoplasm, Er — endoplasmic reticulum, Ly — lysosome, M — mitochondrium, V — vesicles, N — nucleus, Cf — collagen fibrils. x 75 000.

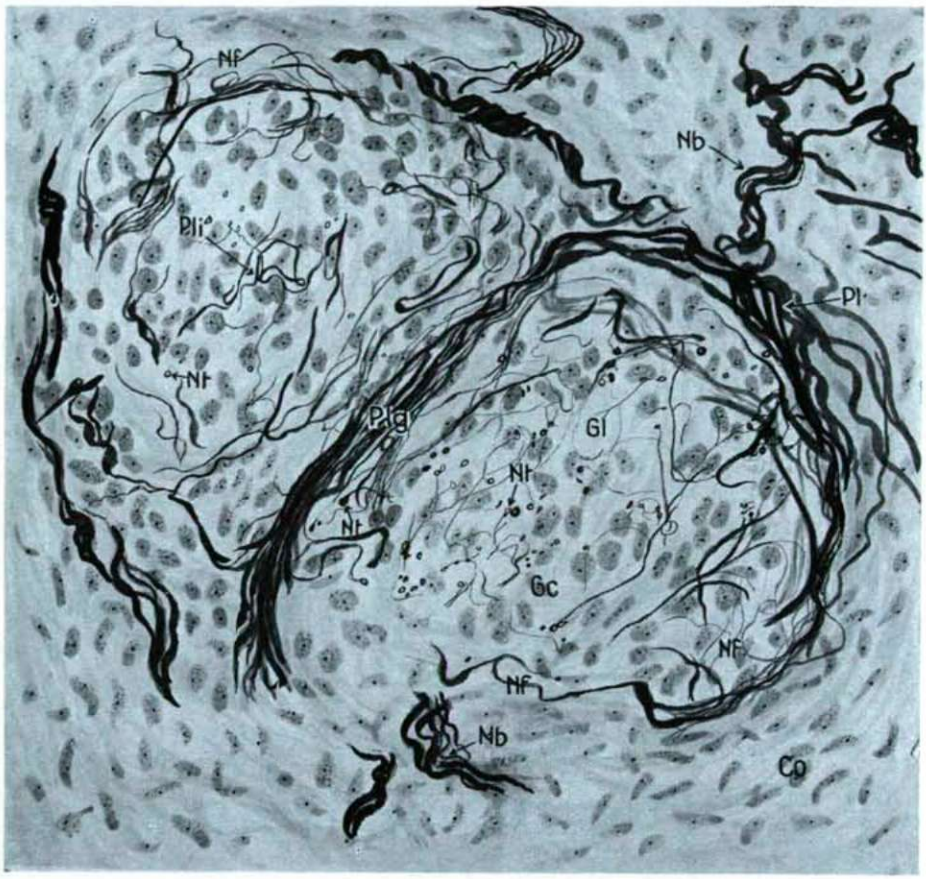

Fig. 8. Homo: carotid body. Nerve supply. Co — connective tissue, Gl — glomerulus, Gc — glomic cell, Nb — nerve bundle, Nf — nerve fibre, Pl — plexus periglandularis, Plg — plexus periglomerularis, Pli — plexus intraglomerularis, Nt — nerve terminal. x 600.

De Castro and Rubio, 1968) have agreed on the fact that there is a synaptic connection of the glomus cells with the nerve fibres that are permeating the glomeruli, in view of the structure of this connection, however, there are great differences between current opinions. We found two forms of the synaptic connections. One of them was observed in a large numbers, the other more somewhat scarcly.

The first form of synapses is a shorter or longer parallel, resp. terminal contact. The situation is in both cases that the neuraxons leaving the Schwann cells the capsel cells respectively are in contact with the bodies of chemoreceptor cells resp. with their processes. In this form of contact, in the axons, the synaptic vesicles, the mitochondria, the neurotubuli and the contact between the axolemma and cell membrane can be seen, in the meeting membranes, however, there are not any synaptic thickenings and in the axons

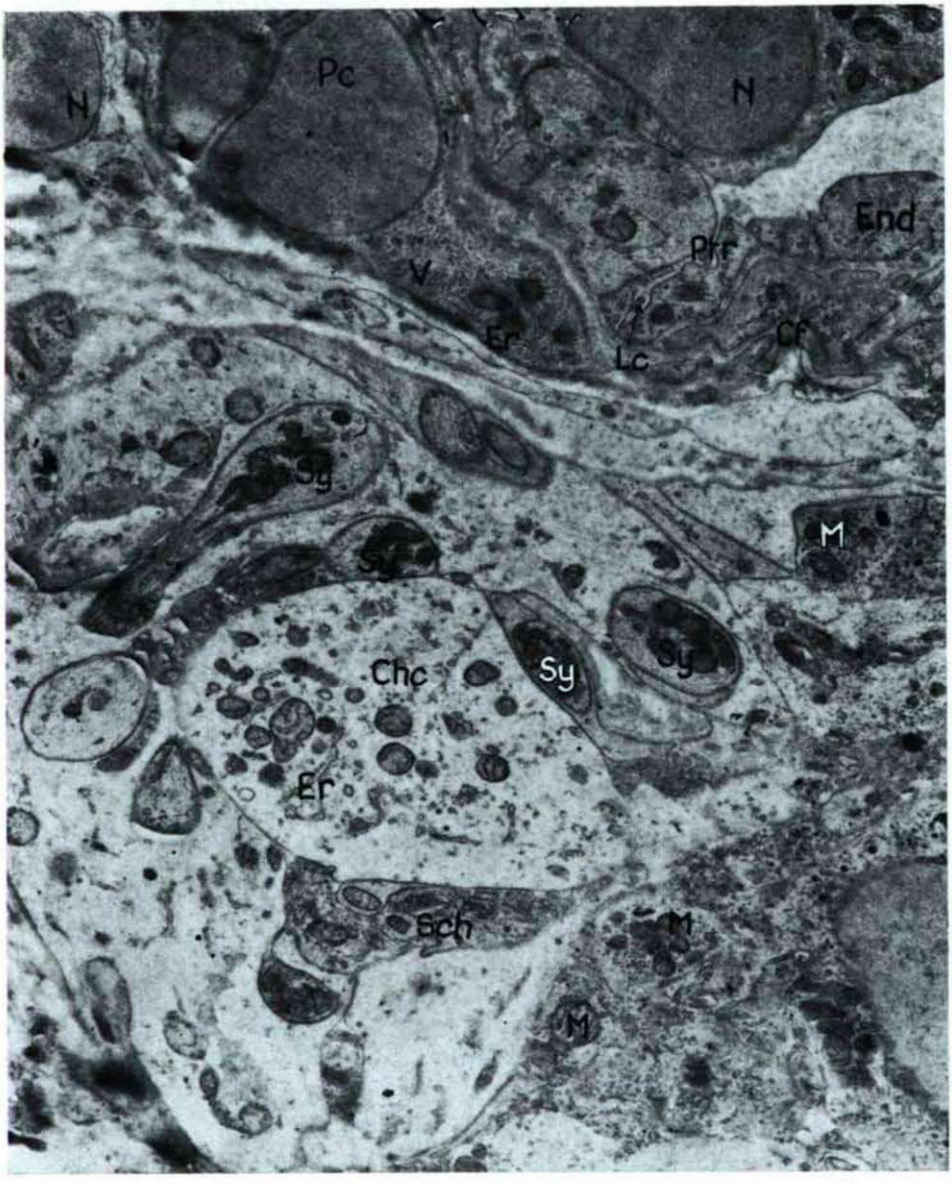

Fig. 9. Homo: carotid body. Afferent synapses. Chc — Chemoreceptor cell, End — endothel cell, Pc — pericyta, Sch — Schwann cell, Er — endoplasmic reticulum, M — mitochondrium, V — vesicles, N — nucleus, Lc — canal, Cf — collagen fibril, Ptr — protrusio, Sy — synapsis. x 25 000.

the grouping consisting of synaptic vesicles are lacking. This synaptic form corresponds to the nerve terminal rings seen through light microscopes. As a consequence of their frequency and pattern, we think that these forms of synapses are afferent synapses conducing impulses from the chemoreceptor cells to the centre in the medulla oblongata (Fig. 9).

The other synaptic form agrees with the forms known from the central nervous system, the striated muscle fibres and the myocardial cells. In these forms we can observe the synaptic vesicles, the synaptic vesicle clusters under the axolemma near to the cell membrane as well the thickenings in the pre- and postsynaptic membrane and the synaptic space (Fig. 10).

As in the synaptic forms of this structure the synaptic vesicle clusters show the direction of impulses although it is impossible to establish with certainly, to where the meeting surfaces belong, we consider as neuraxon that part of the meeting surfaces on which the synaptic vesicles are accumulated. Since in the sensory synapses there are no such clusters, we consider these second forms of the synapses found, as efferent synapses. Among these forms we have found such ones in which the termination of axon meets the surface of a single cells (simple synapsis) and such ones where the same axon is connected with two cells (complex synapsis).

Knowing the conditions found, there arises spontaneously the question, what the efferent synapses are good for, when nowadays it seems to be proved physiologically that the carotid bodies serve the chemoreception. Of course, it could also be thought that the old opinion is right according to which the nerve fibres of the glomus cells are effectors that regulate the secreting processes in the cells. In this sense the carotid bodies could not be considered as receptive organs. This opinion would prove to be right, founded on an objective interpretation of the conditions observed but in the case if the synapses of efferent type were seen in the electron microscopic pictures in a quantity corresponding to the number of terminal rings seen under the light microscope. But this is not the case. The truth is that in the pictures obtained in an electron microscope only a very low number of typically efferent synapses can be seen. Therefore, the opinion, mentioned above, appears to be incorrect and we can not help supposing that the efferent synapses are moving the vessel walls and are efferent bases of the reflex arch the sensory bases of which are given by the pressoreceptors mentioned above or are modulators of the glomic cells as it has been suggested by BISCOE and STEHBENS, (1966) too. As among these synapses there are some forms having oval synaptic vesicles and others having roundish vesicles, according to UCHISONO's theory (1965) we might also think that the former ones are inhibiting synapses (inhibitors) while the latter ones are excitatory in nature (excitators).

Summary

As a result of our investigations with electron microscope on human carotid bodies removed surgically owing to asthma bronchiale, we have establish the following:

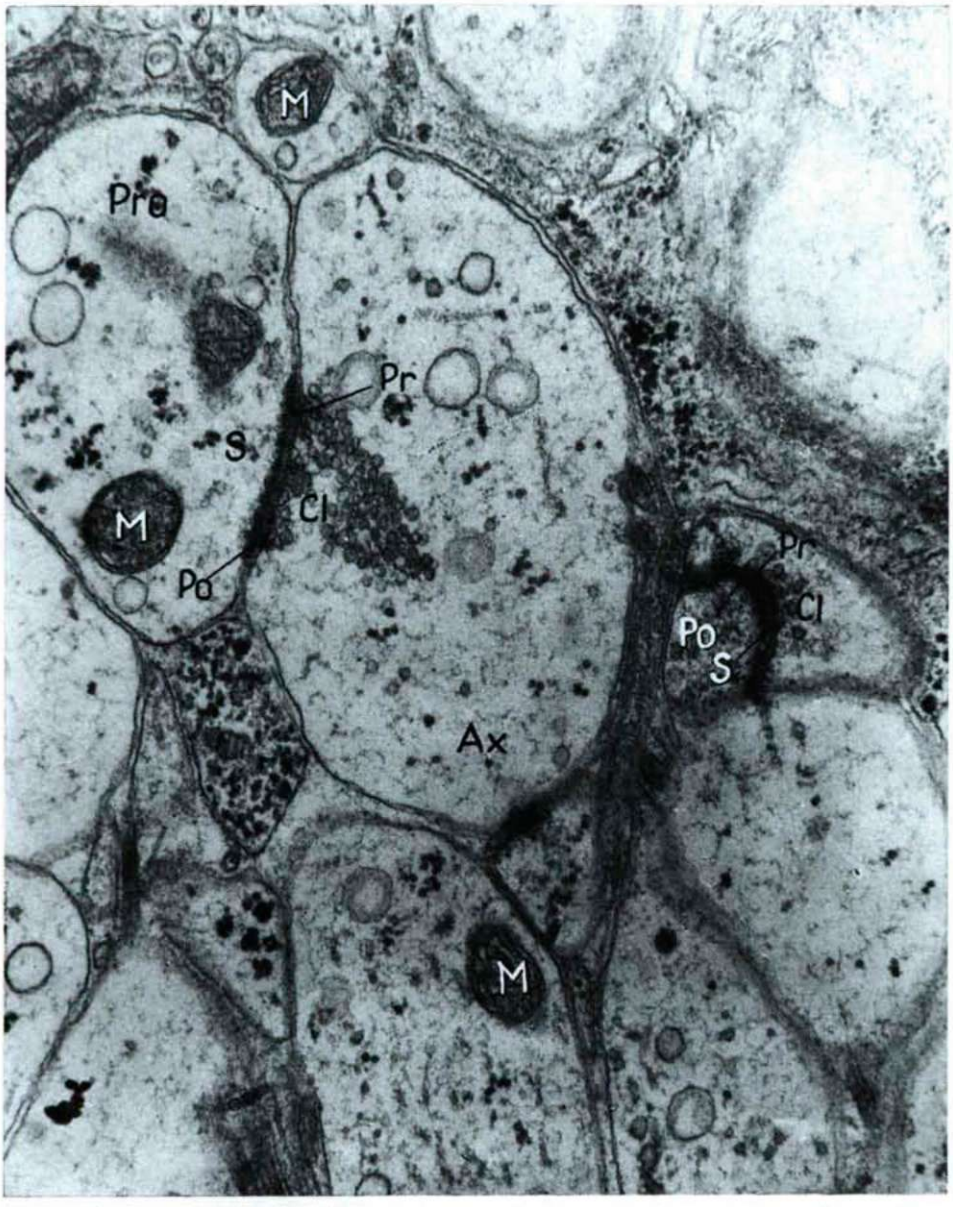

Fig. 10. Homo: carotid body. Efferent synapses. Ax — axon, Pr — presynaptic membrane, S — synaptic space, Po — postsynaptic membrane, Cl — cluster, Pro — process, of chemoreceptor cell, M — mitochondrium. x 75 000.

1) The glomus cells that form the main mass of the carotid bodies can be classified into two groups, one of them are the chemoreceptor cells, the other the capsel cells.

2) The chemoreceptor cells are roundish, their cytoplasm is characterized by the well developed endoplasmic reticulum, the extensive GOLGI complexes, the large crista type mitochondria, the osmiophile bodies, the polymorphous lysosomes, cilia, microvilli and the wide desmosomes.

3) The capsel cells are elongated, their cytoplam is surrounds the likewise long homogenous nucleus in the form of a narrow border. The cytoplasmic inclusions are not developed the cells have some role in covering the nerve fibres.

4) The nerve fibres that mostly belong to the sensory system of the glossopharyngeal nerve reach the chemoreceptor cells covered in SCHWANN cells, resp. capsel cells and after having lost their cover, form synapses with them.

5) The majority of synapses belong to the afferent type. In these the synaptic vesicle clusters and membrane thickenings are lacking. These are the stimulus recipients of the chemoreceptor cells.

6) A little fraction of synapses displays the typical synapsis form. In all of them the characteristic components of the synapses are present. We consider these forms as efferent synapses.

7) As the number of efferent synapses is extremely low, the opinion seems to be correct according to which these are the moving bases of reflex arches, whose sensory bases are the pressoreceptors lying in the wall of blood vessels or modulators of the glomic cells.

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AN ELECTRON MICROSCOPIC STUDY OF DYE-SENSITIZED, LIGHTED TETRAHYMENA PYRIFORMIS LG

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Some micro-organisms containing pigments or dyestuffs of particular structure react to light more intensively than usual: their behaviour as well as their motility change suffer damage and generally perish. This phenomenon was observed comparatively early (Raab, 1900; Straub, 1904; Tappeiner and Jodlbauer, 1904; Metzner, 1921); its cause, however, could be explained reasonably only somewhat later (Blum, 1941). It was ascertained that some strongly light-absorbent pigments, or dyestuffs, the so-called photosensitizers exert a photodynamic effect in the presence of O_2 and in interaction with various macromolecules (Eidus and Kondakowa, 1959; Livingston, 1967; Biczók, 1969a). Experience shows that in the complex formation of substrate and colouring matter the proteins as well photo-oxidizable materials play an important role (Smetana, 1938; Freeman and Giese, 1952; Haurowitz; 1963; McLaren and Shugar, 1964). The localization of the process is in the matrix of cells, or in the single organels, thus in the mitochondria and lysosomes (Cooperstein et al., 1960; Allison et al., 1966; Morgan et al., 1966; Slater and Riley, 1966). The photodynamic effect is followed by photodamage, consequently, it was expected that some alterations would occur in our experimental animals, in the specimens of Tetrahymena pyriformis LG sensitized by rose bengale, eosin, methylene blue, in the sites of localization. This expectation was justifed by simultaneous indications of simple light microscopic examinations concerning *Uroleptus* (Calkins, 1929) and *Paramecium* (Soong et al., 1937), as well as by electron microscope researches (Wise, 1965). The light effect itself followed by a temporary increase in velocity (Saier and Giese, 1966; Biczók, 1969a), the alterations expected in the sensitized cells were considered as indications of changes in movement.

Materials and Methods

The sterile culture bred in darkness, inoculated in every three weeks and centrifuged from 4—6 days old culture was transferred into an ion milieu defined and buffered with phosphate to pH 6,9 (Biczók, 1961), set with methylene blue (Màrck; colour index 52,015), eosin (Fluka; colour index 45,400), and rose bengale, respectively (Fluka; 45,435) in a dilution of 1 : 50 000. The time interval of staining with methylene blue was 30 minutes, with rose bengale and eosin 60 minutes. The samples of *Tetrahymenae pyriformes* were irradiated with a Tungsram bulb of 25 000 lux until the accelerated motion declined

conspicuously. (In unstained substance, no conspicuous decrease was observed even after 40—45 minutes).

After being fixed in 1 per cent OsO_4 for one hour, the lighted and centrifuged animals were dehydrated in the usual alcohol series and, contrasted for 20 minutes, with 3—4 per cent uranylacetate dissolved in 70 per cent alcohol. The animals were embedded in araldite (DURKUPAN; FLUKA), polymerized in a thermostat of 37 °C temperature for one hour and then at 56 °C for two days. Ultra-thin sections were made by PORTER—BLUM ultra-microtome. After staining with Reynold's lead-citrate the sections were examined under Tesla BS 242 D type electron microscope.

Results

The electron microscopic structure of *Tetrahymena pyriformis* is well known (METZ and WESTFALL, 1954; PITELKA, 1963; TOKUYASU and SCHERBAUM, 1965; ALLEN, 1967; LEVY and ELLIOTT, 1968). By this fact, the appreciation of the change in the electron microscopic structure of the unlighted dyesensitized *Tetrahymenae* studied by us, and their comparison with the motion velocity curves obtained by shooting films (BICZÓK et al., 1968) as well as by direct measurements, have considerably been facilitated. This curve, expressing a light-activated oriented photophobatic motion cannot be identified with the motion curve of the native *Paramecium* treated with UV (SAIER and GIESE, 1966), the former one having explicitely two maxima while the curve of *Paramecium* has only one apex. The size of photodynamic effect is expressed by the somewhat steep descending branch of the curve. It is the steepest after being sensitized by rose bengale, then follows the curve of animals stained with eosin, and methylene blue, respectively. Accordingly, the most expressive photodamage could be observed in animals sensitized with rose bengale.

In the electron-optical photographs of the unstained *Tetrahymena* specimens, lighted for 60 minutes, essentially the structural conditions of the non-lighted ones can be observed, only the mitochondria are a little more swollen (T. III, Fig. 11). Basically similar conditions prevail in the sensitized, non-lighted specimens, too, the presence of dyestuff causes no particular change in the intracellular structures (T. I, Figs. 1, 2; T. II, Fig. 9); while in the lighted ones definite changes can be observed.

1. Cortical membrane structures: The cytoplasm of *Tetrahymena pyriformis* is covered by a pellicle consisting of three unit-membrane-

Table I

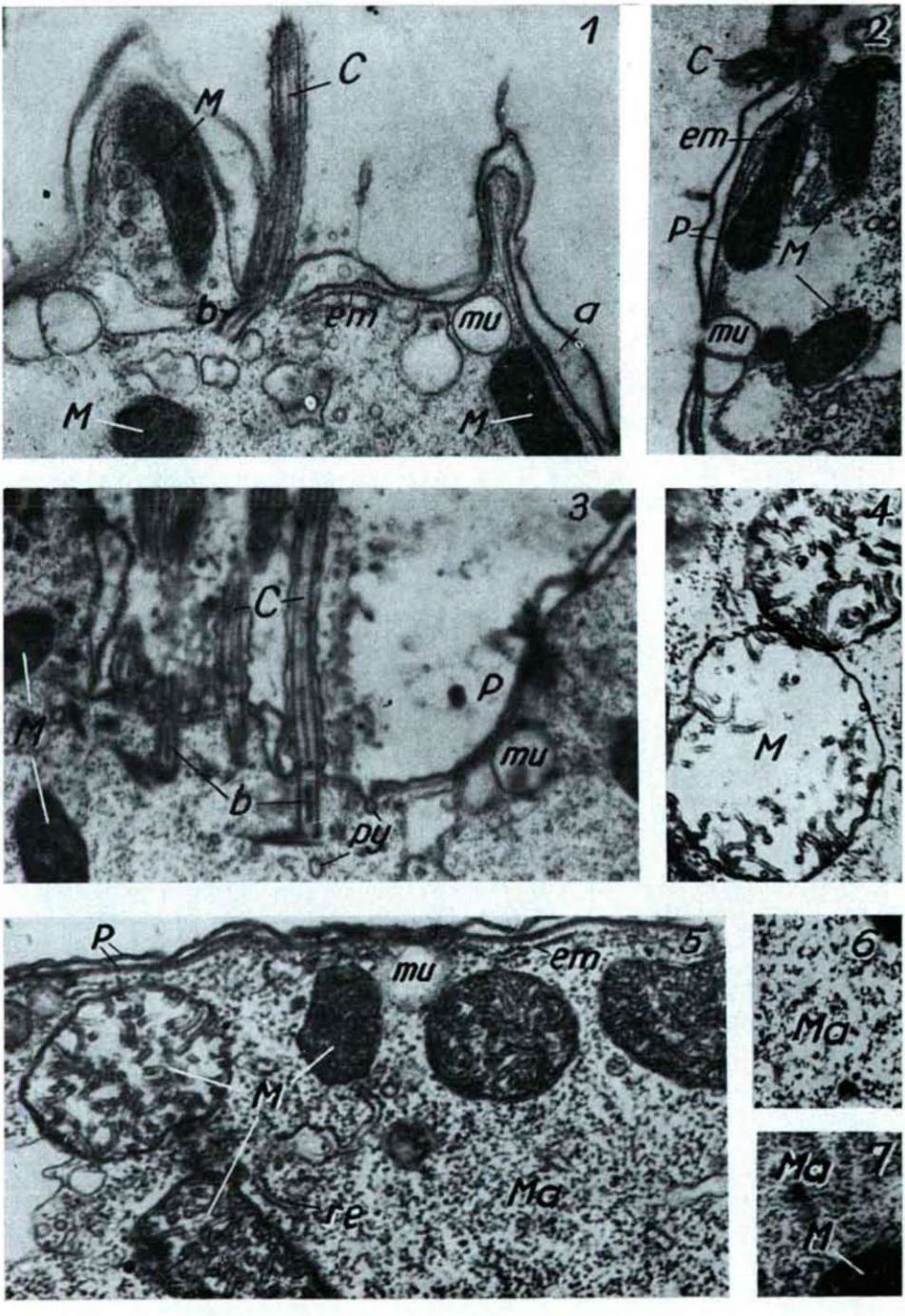
Figs. 1—3. Triple membrane of the pellicle (P) and cilium (C) with basal body (b) of non-lighted *Tetrahymena pyriformis* sensitized with rose bengale (Rb). The mitochondria (M) are intact, the mucinogenic bodies (mu) generally empty. In the cavity of the oral region (Fig. 1) pinocytotic vesicles (py) can be observed. Fig. 1: 25,000 x; Figs. 2 and 3: 18,000 x.

Fig. 4. Photodynamic damage in the tubules of mitochondria (M), in the last phase of the decreasing speed of motion. 28,000 x.

Fig. 5. Intact and partly damaged mitochondria (M), after the development of the light-activated maximum motion speed. The pellicle (P) membranes, the amorphous ectoplasmatic (em) and cytoplasmatic (Ma) substance, as well as the rough endoplasmatic reticulum (re) are essentially unchanged. 18,000 x.

Figs. 6 and 7. The change of the cytoplasmatic granules ribosomes of the sensitized, non-lighted animals (Fig. 7) in aggregation and size, on the effect of light (Fig. 6) 28,000 x.

TABLE I



like layers (ALLEN, 1967). By osmium fixation under the 90—100 Å thick membrane, covering the cilia too, a 75—85 Å thick middle, resp. inner membrane can be seen, separated from each other with a well-descernible lacuna (T. I, Figs. 1, 5; T. II, Fig. 8). On the side of the latter facing the cytoplasm, an electron dense substance is found of about half unit-membrane in thickness, which may double at place whose function is yet unkown (*Fibro-granular* layer at *Paramecium aurelia:* JURAND and SELMAN, 1968) T. I, Figs. 1, 2, 5; T. II, Fig. 9; T. III, Fig. 15). These structures are sensitizers; therefore, they do not show, even in the presence of rose bengale, any photoinduced destructions mentioned by some researchers (BLUM, 1941; GIESE, 1967), a phenomenon preparing the permeation of xanthens. In the arranged cortical membrane structures a desorganization occurs only during the swelling of the body after the light-activated motion having ceased (T. III, Fig. 15).

2. Nuclear membrane: On the cross-section of macronucleus, the double membrane separating cytoplasm and nucleoplasm and between them the less dense (PITELKA, 1963), so called perinuclear space can be observed distinctly. The continuous membrane is interrupted by pores. These structures in the sensitized *Tetrahymenae* seems to be strongly lightresistant at the applied degree of illumination. They have not shown any photodynamic damage even in cases where in other structures the sings of desorganization could be well observed (T. III, Figs. 12, 13).

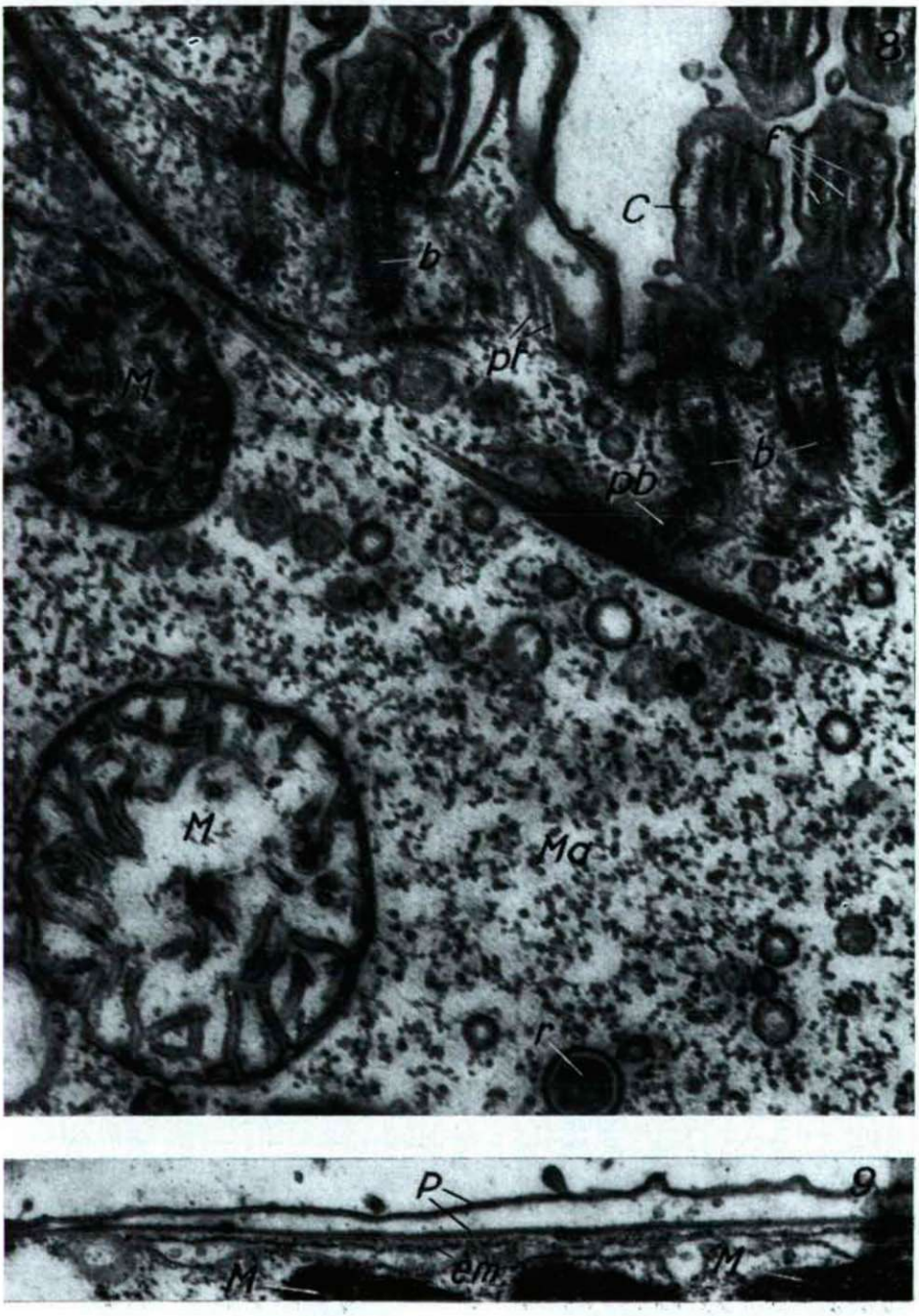
3. Mitochondria: From the double unit membranes of the mostly ovoid or elongated sponge-finger-vake-like organel (T. I, Figs. 1—2; T. III, Fig. 11) separated by a fissure of low electron density, mainly the outer one shows a quality of light resistance. It is conspicuous and characteristic that a considerable part of these organels is oriented mostly into the cavities of the 17 ribs of ectoplasm, in the vicinity of cilia (ALLEN, 1967, p. 554, T. I, Fig. 1). The single sensitizers may supposedly work their way among the macromolecules, and possibly into them, establishing contact with the enzymes of the respiratory chain (CHALAZONIZIS, 1964). It was therefore not surprizing that the most striking photodamage could be observed on the inner membrane in the mitochondria, mainly in their tubules (T. I, Figs. 4, 5; T. II, Fig. 8; T. III, Figs. 14, 15). Tie tubules have sometimes desintegraed almost entirely, the electron dense substance was strongly reduced. The phenomenon is similar to the laser- induced mitochondrium damage in some protozoa, after some vital dyestuffs, primarily by the permeation of JANUS GREEN B known as a particular mitochondrium dyestuff (STORB, AMY, and WERTZ, 1966). It is conspicuous that staining with rose bengale a photodestruction in the organel takes place immediately after illumination following the appearance of the

Table II

Fig. 8. Damage of the mitochondria of sensitized, lighted specimens in the phase of decreasing speed of motion. The central and peripheral fibrils (f) of cilia (C), the basal body (b) the peribasal bodies in its vicinity (pb) with the tubular and amorphous components, and the postciliary microtubules (pt) suffered no photodamage. The granules of cytoplasm (Ma) are aggregated: 56,000 x.

Fig. 9. and T. III, Fig. 11. In the unstained lighted animals the pellicle (P), the amorphous ectoplasmatic substance (em), the mitochondrial (M) membranes, the lipid-like bodies (L), are intact. Fig. 2: 18,000 x; T. III, Fig. 2: 36,000 x.

TABLE II



first velocity maximum of motion (T. I, Fig. 5); in others, however, it occurs only after motionless period, when the animal is incapable of any reactivation even if the light-effect had ceased. This phenomenon may obviously be attributed to the differences between the functional states of the single mitochondria.

4. Lipid and other bodies: In almost every part of cytoplasm we can sometimes find a great number of lipid-like, round or oval dense bodies of about the size of mitochondria (T. III, Figs. 10, 11, 12) the genesis and function of which could only be partly explained (ALLEN, 1967; TOKUYASU and SCHERBAUM, 1965; LEVY and ELLIOTT, 1968). They are Oil Red O-positive, their majority is homogeneous sometimes with the faint signs of an organization. They are supposed to be formed within the cisterns of the endoplasmatic reticulum (LEVY and ELLIOTT, 1968). This supposition may arouse reflection when we consider that the cytoplasm is rich in lipid bodies, formed rapidly and at the some time poor in endoplasmatic reticulum (particularly of the smooth surfaced type). The riper form of body is covered with a simple membrane. It is remarkable how resistant the lipid bodies and their membranes are to photodamage in case of animals lighted after sensitization, too. The situation is similar to that of the socalled residual bodies and mucoid bodies (mucoid cysts), often containing concentrical myelinlike membranes. The former ones occur sporadically in the intermitochondrial spaces (T. II, Fig. 8; T. III, Figs. 11, 15) as degenerative products (SWIFT and HRUBAN, 1964). The mucoid or mucinogenic bodies, mucocystic vacuoles surrounded by a limiting membrane (TOKUYASU and SCHERBAUM, 1965) are nearly entirely missing from the matrix but they are found in a considerable number under the pellicle (T. I, Figs. 1, 2, 3, 5; T. III, Fig. 15). The wall of these vacuoles remained all the while intact, their amorphous dense substance seems, however, to be fully evacuated as a result of light effects.

5. Cilia: Their attractive structure, function has lately got more and more into the focus of interest (PITELKA, 1963; ROTH, 1958, 1964; ARGENTSINGER, 1965; ALLEN, 1967). The electron optical photographs of their longitudinal section are not showing any essential difference in cases of animals unstained and lighted after being dye-sensitized (T. I, Figs. 1, 3; T. II, Fig. 8; T. III, Fig. 11). Nor are the outer membrane surrounding them, the central and periphal fibrils and the basal body incorporated in the sytoplasm, the probasal body and postciliary microtubules which consist of tpubules and amorphous components (T. II, Fig. 8) at the double membrane approximating the distal part of basal body and at its proximal part, too.

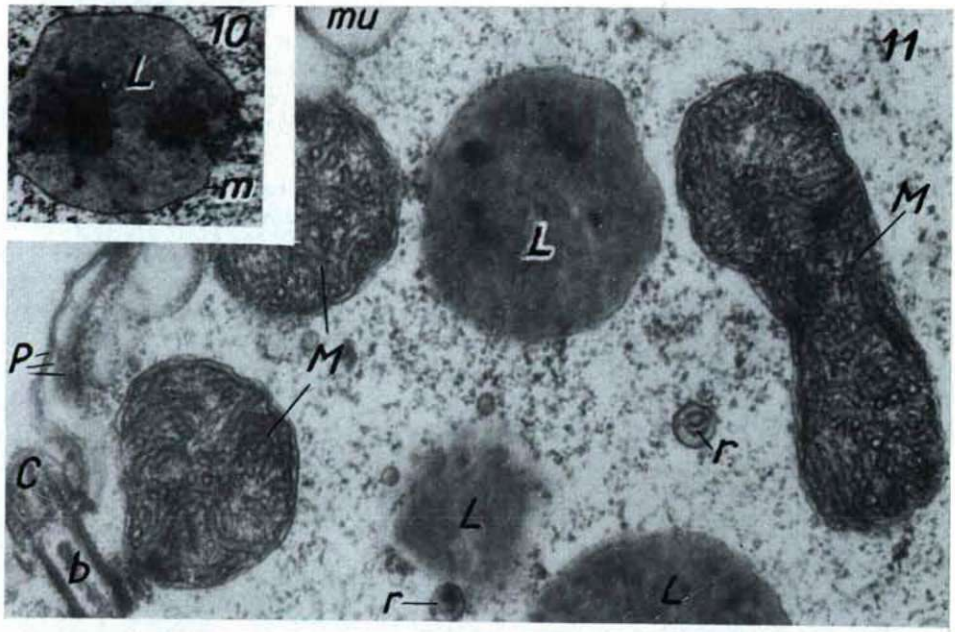
Table III

Fig. 10. The lipid-like body (L) showing some traces of organization, with its simple membrane (m), has been resistant to photodynamic damage: 28,000 x.

Figs. 12. and 13. The intact nuclear membrane of the sensitized lighted animals (Nm). Fig. 12: 28,000 x; Fig. 13: 18,000 x.

Figs. 14. and 15. Photodestruction of electron microscopic structures at sensitized *Tetrahymena pyriformis*, immediately before cessation of photoactivated motion. Apart from mitochondria (M), also the cytoplasmatic granules, pellicular membranes (P) and even the rough endoplasmatic reticulum (re) are damaged: 18,000 x. Sensitized with rose bengale.

TABLE III



6. Cytoplasmatic granula and other components: The cytoplasm of *Tetrahymena piriformis* is granulated with an even density. Concerning their size, the majority of these granules is ribosoma (T. I, Figs. 2, 5, 7; T. III, Figs. 12, 14). Their minority are components of the rough endoplasmatic reticulum (T. I, Fig. 5; T. III, Fig. 5). This reticulum is an efficient means in protein synthesis. It occurs in a conspicuously small amount, in the same way as the smooth surfaced endoplasmatic reticulum. Both forms are strongly resistant to light, even in sensitized specimens. On the other hand, the free ribosomes and other granules differring from them in size, show a considerable variation, forming smaller or bigger nodules, aggregations, and their distribution is uneven (T. I, Fig. 6; T. III, Fig. 14, 15). These observations lead not only to the conclusion that the granules and ribosomes both suffer damage but also to that, that the polypeptides forming the basic structure of cytoplasm become denaturated, in structure whose changes have been emphasized by several authors (MAST, 1932; ERDMANN, 1955; HYMAN and HOWLAND, 1940; DATTA, 1960; MONTGOMERY et al. 1961).

Discussion

A characteristic symptom of the photodynamic effects of various rays is the damage and often destruction of some cells, erythrocytes (BLUM, 1951), spermatozoa, phagocytes, and inside them of lysosomes (ALLISON, A. C. et al., 1966), as well as that of mitochondria (FREDERIC, 1958, etc.). The effect owing to the membrane destruction following the photo-oxidation, releases destruction-inducing enzymes. For an intracellular effect like that, it is thougth to be necessary that the desorganised membrane should transmit the sensitizers, flourescent xanthen-dyes against which it had earlier formed a barrier (BLUM, 1941; ALLISON et al., 1966). The situation is, in fact, that the triple membrane of pellicle, and especially its outer part reaching the cilia, remains intact even in the phase of decreasing speed of motility, when a considerable photodynamic effect in the mitochondria can be observed. Consequently, it is not a precondition of the cells being penetrated by xanthen sensitizers — at least by rose bengale and eosin — that the permeation should have been prepared by the photodamage elicited by these dyestuffs adhering to the membrane. Anyway, this is not the only possibility for an uptake of dyestuffs. We have to take into consideration also the peculiar activity of the intact membrane, the pinocytosis, that according to the light and electron microscopic investigations plays an important role in the intercellular dyestuff enrichment (SCHMIDT, 1962), which is strongly activated in case of *Amoebae* by light (CHAPMAN and ANDERSEN, 1962). The formation of pinocytotic vesicle found in the oral region and its presence in the ectoplasm lead us to beleive that we have to reckon with this form of dyestuff uptake through the pellicle composed by the three membranes (T. I, Fig. 3.).

We have mentioned as a photoactivated phenomenon the provisional increase of the speed of motion as a result of light, followed by a decrease in the speed of motion. We related this phenomenon to the photodestruction

of *Tetrahymena*, resp. of its electron microscopic structure. Excellent investigations have been carried out in connection with the motion of such a character in case of *Paramecium* (SAIER and GIESE, 1966), where the decrease in the speed of motion and in the lashes of cilia was explained by the damage of cilia. The photodynamic damage is analogous in many respect to the destructions caused by various rays. Nevertheless, in case of the sensitized phobophototaxic motion decrease we have looked in vain for the sings of desorganization in cilia. The mitochondria, however, were damaged. It has been obvious, so far, that there may be some connection between the function of cilia and mitochondria (OLLSON, 1962) as these organels form longitudinal series under the pellicle along the kinetosomes, and are in contact with the inner, peribasal layer of the pellicle (CHEISSIN and MOSEVICH, 1962); which may be well observed in our electron optical photographs, too. The ciliary motion is an energy-consuming process (KAMIYA, 1959), the damage of mitochondrium responsible for the oxidative phosphorilation is not indifferent (BEYER, 1960), disturbing the ATP pruduction indispensable for the ciliary function and, in this way, excluding the possiblity of any ciliary activity. This is supported by the O_2 consumption following the light-activated sensitized motion reactions that may be parallelled somewhat with the damage of mitochondria, and with the change in the speed of motion; in the beginning it is conspicuously increasing but later on remarkably decreasing (BICZÓK, 1969a, b).

Summary

The electron microscopic structures have been damaged by light, in the sequence of Rb > E > Mb, in *Tetrahymena pyriformis* LG sensitized by rose bengale (Rb), eosin (E), and methylene blue (Mb). The composed membranes (pellicles) and from them mainly the outer one; the cilia, their fibrillary components, the microtubules, the smooth and rough endoplasmatic reticulum, as well as the lipid and residual bodies often limited by simple membrane were not desorganized perceptively by the photodynamic effect. However, the tubular crystae of mitochondria, the cytoplasmatic basic structures, granula and ribosomes were severely damaged.

The photodamage was manifested more strongly in the phase of the decrease in motion following the increase of light-activated motion (after the second maximum of the motion curve). It is, therefore, obvious that:

The xanthen sensitizers (Rb, E) enter the cytoplasm without damaging the membrane structure. One of the ways of dyestuff uptake may be the pinocytosis that as a dye- and light- activated phenomenon can be manifested through the pellicle, too.

The phase of decreasing speed of the light-activated motion cannot be a result of the decrease of lashing caused by the damage of cilia but much more that of the disturbance and absence of the oxidative phosphorylation as a consequence of the damage of mitochondria in the vicinity of cilia.

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RECENT DATA ON FAUNISTICAL AND ECOLOGICAL CONDITIONS OF ORTHOPTERA AT THE DALMATIAN COAST

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In the faunistical research of the Dalmatian coast a significant place is occupied by the *Orthoptera* fauna. From taxonomic point of view *Orthoptera* had been investigated by many researchers as early as the last century, first of all by BRUNNER (1882), KRAUSS (1888), EBNER (1908), and WERNER (1920). These authors have described a number of new species from this territory, completing their investigations with certain ecological data. Lately, besides the faunistical investigations, some importance has been attached to estimating the ecological conditions of coastal biotopes, as well (KÜHNELT, 1943), for the well-definiable halophilous, macquis and karst-steppe associations of Dalmatia mean a special biotope for the insect population living there. PRAVDIN's fundamental paper (1964) estimates the *Saltatoria* fauna of littoral biotopes as dependent upon vertical distribution, completing them with climatological and phytosociological data. Similar intentions are reflected by ADAMOVICH's (1964) investigations carried out in the environs of Dubrovnik. Us (1964) investigates the conditions of presence and quantity of the *Orthoptera* species in connection with the plant associations in the islands Cres and Losinj, paid attention to macquis associations. Author discusses in this paper the results of his collecting activity in three successive years (August 1964—1966), attaching primary importance to the role of environmental factors and the characterization of biotopes, on the basis of their *Saltatoria* fauna.

Methods

The peculiar phytocoenologic structure of littoral biotopes does not enable collecting by a sweeping net (GALLÉ and GAUSZ, 1968); the species of families *Acrididae* and *Tettigoniidae* are consequently collected one by one. For measuring quantitavely the single biotops under the given experimental conditions, I performed a time collecting of one hour. The single sites of collectings at Bar a and b stations took place in 1965, those of Zaostrog a, b, c, Baska Voda, and Gradac in 1966, while the others in 1964, always at the beginning of August. The time of collecting in August is unfavourable, for at this time the insects of the Adriatic coast are in a state of the so-called „summer pause".

At characterizing the biotops, vegetation has a primary importance, thus I endeavoured to determine, when possible, the plant association. In that task I was supported by the works of ADAMOVICH (1911) and HORVATIC (1927). The observations concerning

the composition of vegetation and the data about the abiotic factors play a part at treating the single biotops together with the data of dominance calculated for the species demonstrated. The nomenclature of species is given on the basis of HARZ's work (1957).

Orthoptera fauna of the single biotops

1. Rijeka

There is a slope of southern exposition 250 m a. s. l.. Its vegetation is strongly overrun by weeds, therefore, the plant association is not definite, its height varies between 3—10—20 cm. The *Orthoptera* fauna with low species and specimen numbers is formed first of all by euriplastic species. (Table 1)

Table 1

Species	Number	D p. c.
Phaneroptera quadripunctata BR. v. W.	3	10.7
Pezotettix giornae ROSSI	18	64.0
Calliptamus italicus L.	4	14.6
Oedipoda coerulescens L.	3	10.7

2. Medveja

Even in the sparse, shaded, weedy underwood of *Pinus halepensis* only species with wide tolerance limit subsist, while the complete lack of herbivorous and graminivorous species is the result of the complete absence of *Gramineae* vegetation. (Table 2)

Table 2

Species	No.	D p. c.
Pezotettix giornae ROSSI	21	56.8
Calliptamus italicus L.	7	17.2
Oedipoda coerulescens L.	10	26.0

3. Lovranska Draga

The vegetation of the grass-land 400—500 m a. s. l. is composed of *Melica, Briza, Setaria,* and *Arrhenaterum* stand. The height of vegetation is 20—25—30(—40) cm, the coverage is 90—95 per cent. The soil became only somewhat karstic and compared with the littoral zone it is of lower air temperature with a 6—7 °C. The *Saltatoria* population consists of karst-steppe species (*Tylopsis liliifolia* FABR., *Phaneroptera quadripunctata* BR. v. W.). The number of locusts is rather high but also the *Oedipoda germanica* LATR. living in higher lying biotops of the littoral zone can be found. Faunistically the *Glyptobothrus eisentrauti* RME. is interesting for it has not been demonstrated in Dalmatia yet, and its nearest locality is in Croatia (RAMME, 1951). (Table 3)

Table 3

Species	No.	D p. c.
Tylopsis liliifolia FABR.	8	10.1
Phaneroptera quadripunctata BR. v. W.	16	20.2
Acrometopa macropoda BURM.	1	1.3
Pachytrachis striolatus FIEB.	2	2.7
Rhacocleis germanica H.—S.	5	6.8
Pezotettix giornae ROSSI	12	15.1
Odontopodisma schmidti FIEB.	1	1.3
Oedipoda coerulescens L.	4	5.2
Oedipoda germanica LATR.	6	8.1
Omocestus ventralis ZETT.	10	12.9
Omocestus haemorrhoidalis CHARP.	3	4.1
Glyptobothrus eisentrauti RME.	4	5.2
Chorthippus longicornis LATR.	3	4.1
Gomphocerippus rufus L.	2	2,7

4. Split

Mixed macquis vegetation on the side of the mountain Marjan *(Juniperus oxycedrus, Cistus villosus, Agave americana)*, the cover being 75—80 per cent. We have found the typical macquis-dwelling *Orthoptera* population, mentioned by PRAVDIN (1964). (*Anacridium aegyptium* L., *Acrotylus patruelis* H.—S., *Aiolopus strepens* LATR.). (Table 4).

Table 4

Species	No.	D p. c.
Pezotettix giornae ROSSI	36	43.4
Anacridium aegyptium L.	4	8.7
Calliptamus italicus L.	5	6.1
Oedipoda coerulescens L.	3	3.8
Acrotylus patruelis H.—S.	11	13.1
Aiolopus strepens LATR.	14	16.7
Aiolopus thalassinus FABR.	6	7.2

5. Solin

There is a deep lying, dry biotop profusely covered by weeds *(Festuca, Xanthium)*, the height of vegetation being 3—5—7—10 cm, coverage is 85—90 p. c. The plant association is a transition between the karst-steppe and the macquis. Particularly characteristic are the specimens of *Bacillus rossii* F. and *Acrida mediterranea* DIRSH in nymphal state, as well as that of *Omocestus petraeus* BRIS. (Table 5)

6. Klis

There is a pasture of poor quality on a higher level (400 m); *Onopordetum illyricum* association, the height of vegetation being 7—10—15(—30—40) cm, coverage is 90—95 per cent. The population is formed first of all by

Table 5

Species	No.	D p. c.
Bacillus rossii F.	8	13.2
Mantis religiosa L.	4	6.9
Pezotettix giornae ROSSI	29	49.1
Calliptamus italicus L.	1	1.7
Oedipoda coerulescens L.	5	9.4
Acrida mediterranea DIRSH	6	10.3
Omocestus petraeus BRIS.	5	9.4

macquis-dwelling elements. *Tessalana tessalata* CHARP. and the *Calliptamus barbarus barbarus* COSTA are worth to mention. (Table 6)

Table 6

Species	No.	D p. c.
Mantis religiosa L.	7	14.0
Tessalana tessalata CHARP.	1	2.0
Pezotettix giornae ROSSI	16	32.0
Calliptamus italicus L.	6	12.0
Calliptamus b. *barbarus* COSTA	5	10.0
Oedipoda coerulescens L.	3	6.0
Oedipoda germanica LATR.	3	6.0
Omocestus petraeus BRIS.	4	8.0
Glyptobothrus brunneus THUNBG.	5	10.0

7. Baska Voda

It is a mixed stand of karst-steppe and macquis (*Helichrysetum italici* and *Pistacietum lentisci* associations), the height of vegetation being 10—20—30 cm, coverage is 75—80 per cent. I have found there the grasshopper species *Platycleis stricta* ZELL., characteristic of South Dalmatia (BEIER, 1954) and *Empusa fasciata* BRULLÉ, living in macquis. The other elements of the populations can be found primarily in the macquis. (Table 7)

Table 7

Species	No.	D p. c.
Mantis religiosa L.	3	3.1
Empusa fasciata BRULLÉ	2	2.0
Tylopsis liliifolia FABR.	3	3.1
Platycleis stricta ZELL.	1	1.0
Pezotettix giornae ROSSI	20	20.4
Calliptamus italicus L.	4	4.1
Calliptamus b. *barbarus* COSTA	2	2.0
Oedipoda coerulescens L.	7	7.1
Oedipoda germanica LATR.	6	6.1
Acrotylus insubricus SCOP.	4	4.1
Acrotylus patruelis H.—S.	11	11.2
Aiolopus strepens LATR.	26	26.5
Acrida mediterranea DIRSH	4	4.1
Glyptobothrus vagans EVERSM.	4	4.1

8. Zaostrog

a) It is in the littoral zone the undergrowth of *Ficus carica* and *Olea europaea* stand. Apart from the shrubs occuring sparsely, it is a karst-steppe vegetation, being 3—5—7—10 cm high, coverage is 85 per cent. The population is formed mainly by macquis-dwelling elements but, owing to deep shade, it has a low specimen number compared to other biotops. *Rhacocleis bucchichi* HERM. has a place in Us's (1967) Jugoslav *Orthoptera* catalogue among insular endemics, thus it is its first continental occurence. (Table 8)

Table 8

Species	No.	D p. c.
Pachytrachis frater BR. v. W.	1	2.9
Rhacocleis bucchichi HERM.	1	2.9
Pteronemobius heydeni FISCH.	4	11.5
Pezotettix giornae ROSSI	9	26.1
Calliptamus italicus L.	3	8.6
Oedipoda coerulescens L.	2	5.7
Acrotylus patruelis H.—S.	4	11.5
Aiolopus strepens LATR.	11	31.8

b) *Helichrysetum italici* is a karst-steppe association somewhere with a stand of *Quercus coccifera* and *Nerium oleander;* vegetation height being 10—20—30(—40) cm, coverage is 85—90 per cent. As compared with those of the former biotop, the conditions of soil structure and shade are more favourable. Both the macquis and karst-steppe species are dominant, and even the *Oedipoda miniata* PALL., characteristic of the halophilous vegetation also occurs here (Table 9)

Table 9

Species	No.	D p. c.
Phaneroptera quadripunctata BR. v. W.	4	6.0
Pezotettix giornae ROSSI	15	22.5
Calliptamus italicus L.	6	8.9
Oedipoda miniata PALL.	2	3.0
Oedipoda coerulescens L.	5	7.4
Oedipoda germanica LATR.	2	3.0
Acrotylus patruelis H.—S.	7	10.4
Aiolopus strepens LATR.	14	21.0
Aiolopus thalassinus FABR.	3	4.5
Omocestus ventralis ZETT.	7	10.4
Glyptobothrus vagans EVERSM.	4	6.0
Glyptobothrus brunneus THUNB.	3	4.5

c) The typical *Pistacietum lentisci* macquis is in a height of 100 m a. s. l., with a vegetation height of 60—70 cm, little dense clumps of grass. The most important species of the population are *Pezotettix giornae* ROSSI and *Aiolopus strepens* LATR. but the solitaria phase nymph of *Locusta migratoria* L. can be found (Table 10).

Table 10

Species	No.	D p. c.
Phaneroptera quadripunctata Br. v. W.	3	3.6
Rhacocleis bucchichi Herm.	1	1.2
Pezotettix giornae Rossi	20	23.8
Anacridium aegyptium L.	6	7.1
Calliptamus italicus L.	8	9.5
Locusta migratoria L.	1	1.2
Oedipoda coerulescens L.	4	4.8
Oedipoda germanica Latr.	4	4.8
Acrotylus patruelis H.—S.	8	9.5
Aiolopus strepens Latr.	23	27.4
Omocestus ventralis Zett.	6	7.1

9. Gradac

It is the weed association of the cultivated stands of *Olea europaea*, *Ficus carica*, and *Vitis vinifera*, mainly with macquis plants. Vegetation height is strongly heterogeneous, coverage is 60—70 per cent. Conditions are more and less similar to those of the former biotop, the role of karst-steppe species being negligible. *Tetrix ceperoi balcanicus* Karam. is new for the Jugoslav fauna; altough mentioned by Pravdin (1964), it is not included in Us's (1967) catalogue (Table 11).

Table 11

Species	No.	D p. c.
Phaneroptera quadripunctata Br. v. W.	4	6.1
Pholidoptera dalmatica Kr.	1	1.6
Tetrix ceperoi balcanicus Karam.	1	1.6
Pezotettix giornae Rossi	18	27.4
Calliptamus italicus L.	5	7.5
Oedipoda coerulescens L.	4	6.1
Oedipoda germanica Latr.	4	6.1
Sphingonotus caerulans L.	2	3.1
Acrotylus patruelis H.—S.	6	9.0
Aiolopus strepens Latr.	21	31.9

10. Mljet

The underwood of *Pinus halepensis*, *Pinus pinea* and *Ceratonia siliqua* stand is the southern macquis, *Myrtetum italici*, the grass level is negligible; along the paths somewhat weedy. The population is very poor in species and, besides the macquis elements, we may find *Glyptobothrus lesinensis* Kr. as a dominant species, also mentioned by Krauss (1888) and Ramme (1951) from the island Hvar and reported in the Jugoslav fauna catalogue only from that habitat (Table 12).

Table 12

Species	No.	D p. c.
Pezotettix giornae ROSSI	15	28.5
Calliptamus italicus L.	6	11.4
Oedipoda coerulescens L.	2	3.8
Acrotylus patruelis H.—S.	7	13.3
Omocestus ventralis ZETT.	3	5.7
Glyptobothrus lesinensis KR.	19	37.3

11. Hercegnovi

There is first of all a mixed stand of decidous and evergreen bushes, here and there with *Gramineae* vegetation *(Stipa, Briza, Sesleria),* 10—20—30(—40) cm high, coverage is 95—100 per cent. The cricket species, *Trigonidium cicindeloides* RAMB. is characteristic for South Dalmatia in areas shaded by shrubs. A number of the carnivorous locust species (*Rhacocleis germanica* H.—S., *Saepiana saepium* YERS., *Tettigonia viridissima* L., *Roeseliana roeselii* HGB.) can also be found together with the species of the xerophilous grass-land meadows of the Carpathian Basin. (*Glyptobothrus brunneus* THUNB., *Omocestus ventralis* ZETT.) *Poecilimon fussi* BR. v. W. in Dalmatia has been first demonstrated in that biotop (Table 13).

Table 13

Species	No.	D p. c.
Tylopsis liliifolia F.	7	7.1
Phaneroptera quadripunctata BR. v. W.	8	8.2
Acrometopa macropoda BURM.	2	2.0
Poecilimon fussi BR. v. W.	1	1.0
Tettigonia viridissima L.	1	1.0
Saepiana saepium YERS.	2	2.0
Roeseliana roeselii HGB.	2	2.0
Rhacocleis germanica H.—S.	7	7.1
Pteronemobius heydeni FISCH.	3	3.1
Trigonidium cicindeloides RAMB.	4	4.1
Pezotettix giornae ROSSI	18	18.5
Anacridium aegyptium L.	2	2.0
Calliptamus italicus L.	4	4.1
Calliptamus b. *barbarus* COSTA	3	3.1
Oedipoda coerulescens L.	6	6.1
Aiolopus strepens LATR.	2	2.0
Omocestus ventralis ZETT.	7	7.1
Glyptobothrus vagans EVERSM.	19	19.5

12. Melnije

300 m a. s. l., there is a *Helichrysetum italici* association, sparsely mixed with macquis. Vegetation height is 15—20—30(—45) cm, coverage is 100 per cent. Apart from the Central-European mountaineous species (*Pachytrachis gracilis* BR. v. W., *Pholidoptera aptera* FABR.), the population is formed by euriplastic species distributed widely (Table 14).

Table 14

Species	No.	D p. c.
Platycleis grisea FABR.	2	6.7
Pholidoptera aptera FABR.	2	6.7
Pachytrachis gracilis BR. v. W.	1	3.3
Pezotettix giornae ROSSI	12	39.9
Calliptamus italicus L.	2	6.7
Oedipoda coerulescens L.	4	13.3
Oedipoda germanica LATR.	5	16.7
Chorthippus longicornis LATR.	4	13.3

13. Zanjevdo

At a height of 1000—1200 m a. s. l., on an almost bare southern slope, there is *Saltatoria* fauna of a low species and specimen number. In higher regions, apart from the common *Oedipoda germanica* LATR., *Lucusta migratoria* L. can also be found (Table 15).

Table 15

Species	No.	D p. c.
Locusta migratoria L.	1	3.8
Oedipoda coerulescens L.	7	26.6
Oedipoda germanica LATR.	18	69.6

14. Bar

a) There is a *Quercetum ilicis* association mixed with macquis and karst-steppe associations *(Scolymetum hispanici, Eryngietum echinosporium).* As compared with macquis associations, the significance of *Anacridium aegyptium* L. is lower. From the carnivorous species *Eupholidoptera chabrieri* CHARP. was found here common (Table 16).

Table 16

Species	No.	D p. c.
Empusa fasciata BRULLÉ	2	2.0
Tylopsis liliifolia FABR.	4	4.1
Phaneroptera quadripunctata BR. v. W.	2	2.0
Eupholidoptera chabrieri CHARP.	4	4.1
Rhacocleis germanica H.—S.	4	4.1
Pezotettix giornae ROSSI	19	19.4
Anacridium aegyptium L.	2	2.0
Calliptamus italicus L.	7	7.1
Oedipoda miniata PALL.	3	3.1
Oedipoda coerulescens L.	6	6.1
Acrotylus patruelis H.—S.	10	10.2
Aiolopus strepens LATR.	21	21.5
Acrida mediterranea DIRSH	4	4.1
Glyptobothrus vagans EVERSM.	6	6.1
Glyptobothrus brunneus THUNB.	4	4.1

b) There is a littoral halophilous vegetation, overrun by weeds *(Phragmites, Juncus, Salicornia, Plantago).* The population is formed, apart from Central-European xerophilous and even hygrophilous elements by South Dalmatian ones *(Tessalana orina* BURR, *Euchorthippus declivus stichai* MAR.) espeically by macquis-dwelling species (Table 17).

Table 17

Species	No.	D p. c.
Tessalana orina BURR	2	3.6
Eupholidoptera chabrieri CHARP.	2	3.6
Pezotettix giornae ROSSI	23	42.3
Acrotylus patruelis H.—S.	4	7.2
Aiolopus strepens LATR.	14	25.3
Stenobothrus fischeri EVERSM.	2	3.6
Chorthippus albomarginatus DEG.	3	5.4
Chorthippus dorsatus ZETT.	3	5.4
Chorthippus loratus FISCH.	1	1.8
Euchorthippus declivus stichai MAR.	1	1.8

Evaluation of results

Because of the great differences in the distances of the biotops investigated and in the time lape of collectings, I can give but a general characterization of the population groups of *Orthoptera* in Dalmatia. The evaluation is the more difficult for I have no climatic data and the number of collectings is low, too. Having collected in the most important littoral plant associations certain classifications may be carried out. It is to be emphasized that at establishing the groups of populations no importance has been attached to the euriplastic species that are common everywhere (*Pezotettix giornae* ROSSI, *Calliptamus italicus* L., *Oedipoda coerulescens* L.) but only to the elements of local character of a given biotop. Similarly, the role of the *Tettigoniidae* species occuring only in a few biotops is less important for characterization. In the following the separable *Saltatoria* population groups will be discussed.

A. *Macquis* populations. It should be mentioned that the *Saltatoria* fauna of a real macquis plant association is generally very poor; the fauna of the macquis mixed (with karst-steppe and weed associations) can, however, be well characterized. In biotops like these, *Acrotylus patruelis* H.–S., *Aiolopus strepens* LATR., *Anacridium aegyptium* L., *Omocestus ventralis* ZETT. are the most important species and a secondary role is played by *Empusa fasciata* BRULLÉ, *Locusta migratoria* L., *Glyptobothrus vagans* EVERSM. In a macquis vegetation, the forbivorous species are dominant and the graminivorous and herbivorous elements are rarer also in mixed stands (Split, Mljet, Bar a, Zaostrog a, c, Baska Voda stations).

B. Karst-steppe populations of littoral zone. The macquis-dwelling elements may be observed here, too, with lower dominance; the population group is, however, characterized by other, so-called „phytocolous elements" as *Tylopsis liliifolia* FABR., *Phaneroptera quadripunctata*

BR. v. W. and *Acrometopa macropoda* BURM. In such biotops the carnivorous grasshopper species have a greater role. (Hercegnovi, Gradac, Zaostrog b stations).

C. Karst-steppe populations of higher sites. They are the species of the former two population groups, in a more moderate amount. The species of the Central European xerophilous meadows are characteristic, with a moderate dominance (*Glyptobothrus brunneus* THUNB., *Omocestus ventralis* ZETT.), and *Oedipoda germanica* LATR. (Lovranska Draga, Melnije, Klis stations).

D. Littoral grassland populations. Characteristic dominant species are *Acrida mediterranea* DIRSH, *Bacillus rossii* F., and *Mantis religiosa* L. that are in nymphal state even in August. There is a decrease in specimen density, as compared with the former biotops. (Solin station).

E. Subalpine populations. On rocky mountain sides of very scarce vegetation, the *Saltatoria* fauna is formed by *Oedipoda germanica* LATR. and *Oedipoda coerulescens* L. (Zanjevdo station).

F. Halophilous littoral populations. From the macquis-dwelling species *Aiolopus strepens* LATR. and *Acrotylus patruelis* H.—S. occur as well as the Central Europen xerophilous species. (Bar b station).

G. Ruderal populations. Only euriplastic species occur as components of these populations (Rijeka, Medveja stations).

It is important to be mentioned that these populations mostly cannot be seperated definitely from one another because transitory types are also frequent. One of the drawbacks of these investigations is that no data about the populations in the oak and beech zones of higher territories were obtained.

Summary

In the months August of 1964—1966 I collected 1046 specimens of 54 species in the territory of Dalmatia in 17 biotops. From the species demonstrated, *Glyptobothrus eisentrauti* RME. and *Tetrix ceperoi balcanicus* KARAM, as well as *Euchorthippus declivus stichai* MAR. are new to the fauna of Dalmatia, although the last two have been mentioned by PRAVDIN (1964). The presence of *Glyptobothrus lesinensis* KR., known so far fram Hvar, in the island Mljet, and the specimens of *Rhacocleis bucchichi* HERM., known so far from islands, and now found in the mainland, are similarly worth mentioning.

The *Orthoptera* populations in Dalmatia can be separated from one another on the basis of the single vegetation types and, in that relation, they can be classified on the basis of my collectings in seven groups. From there are of outstanding importance the macquis and karst-steppe associations, and their intermediates from which the *Saltatoria* fauna can be well determined. The other biotop types are rarer and the characterization of their fauna is more complex. There are a few species (*Pezotettix giornae* ROSSI, *Calliptamus italicus* L., *Oedipoda coerulescens* L.) common in the most of the biotops.

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HISTOLOGICAL AND HISTOCHEMICAL INVESTIGATIONS OF OESOPHAGUS AND STOMACH OF THE MARSH-FROG (RANA RIDIBUNDA PALL.)

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The attention of anatomists was attracted long ago by the investigation of the gastro-intestinal tract of frogs. In this respect the books of Krause (1923), Kükenthal and Matthes (1950) are especially worth mentioning. These, apart from treating the anatomical conditions, are summing up also the histological results till then the date of publication. From these, as well as from the other observations examining different species we can point out several unsolved problems in the histological structure especial in the innervation of intestinal tract (Gunn, 1951). A part of them has been elucidated by the help of modern methods, the other part, however, is still awaits solution (Feldberg, 1952; Donhoffer, 1959).

We have, therefore, undertaken the tasks to investigate the displacement of plexuses in the intestinal tract of the marsh-frog, the types of the nerve cells of the vegetative plexuses and their synaptic connections, not only by impregnation but also by histochemical method.

Materials and Methods

Our investigations have been carried out on some well developed specimens of marsh-frogs (*Rana ridibunda* Pall.). Their intestinal tract, similarly to that of the other vertebrate groups, divides into oesophagus, stomach, small and large intestines. In this paper we are discussing only the results of our investigations concerning the oesophagus and the stomach.

After section the oesophagus was fixed partly in Bouin's and Carnoy's fixing mixture and partly in neutral formalin of 10 p. c. The 5—7 μ sections made of a matter embedded in paraffin were stained with Heidenhain's iron-haematoxylin, Mallory's mixture, and haematein-eosin. A part of the intestinal tracts fixed in formol has been used for the demonstration of cholinesterase, carried out with Koelle-Friedenwald's procedure (1949), and its form is modified by Gerebtzoff, Coupland and Holmes (1957), and with a procedure applying thioacetic acid. In both cases DFP and prostigmine were used for separating specific and non-specific esterase. The other part of intestine tracts has been impregnated with the Bielschowsky—Ábrahám (1951) and Bielschowsky—Gros—Cauna methods after having been fixed in formol for a longer period time.

Discussion of results

Oesophagus

The oesophagus running caudally from the pharynx is comparatively short. On its inner surface longitudinal plicae are found. These are protrusions of the mucous tunic. In the cranial part the epithelium is stratified, in the caudal part it is a simple ciliated cylindrical epithelium. Among the epithelial cells simple salivary glands varying in number can be observed (SALAMON, 1955). The proper tunic is thin, in the vicinity of stomach, however, thicker, containing various quantities of composed tubular glands. Among them a great number of capillaries are found which may run up to the basis of the epithelium. The thickest histological layer of the oesophagus is the muscular tunic. It consists of an inner, thicker, circular and an outer, thinner, longitudinal smooth muscle layer, separated from each other by a connective tissue septum. The longitudinal muscle layer is covered by the external tunic that is rich in elastic fibres, covered from the autside by a simple flatteden epithelium.

At the boundary of the external tunic and the logitudinal muscle layer of the muscular tunic smaller or bigger nerve-trunks are found, with scattered single unipolar nerve cells (Table I, Fig. 1). The trunks have cerebrospinal myelinated fibres and also vegetative ones with SCHWANN's membrane (HARTING, 1934; SOTELO, 1954). The thinner trunks running between the longitudinal and circular smooth muscle layers (Table I. Fig. 2) form the AUERBACH's myenteric plexus (IKEDA, 1954). The nerve cells forming smaller groups in the plexus in spite of the variety of their forms, belong to the DOGIEL's cell types (Table I, Figs. 3, 4). From the two kinds of DOGIEL's cell type the DOGIEL's I occurs in higher numbers. Nerve cells can be observed not only in the area of plexus but also distally from it, at the inner boundary of the circular muscle layer.

One part of the fibres belonging to the myenteric plexus runs through the circular muscle layer into the mucous tunic plexus which contains mainly unipolar nerve cells (SMIRNOW, 1899; Table II, Figs. 1, 2). We consider this plexus to be homologous to MEISSNER's plexus in the submucous tunic of other vertebrates. KRAUSE (1923) found this plexus to be free from nerve cells in the intestinal tract of *Rana esculenta*. As we mentioned before we observed nerve cells in the lamina propria of the oesophagus of the marsh-frog. The myelinated and non-myelinated fibres originating from the plexus, diverge abundantly at the basis of epithelium and among the glandular tubules and end freely (ÁBRAHÁM, 1936; HONJIN, 1951; SOTELT, 1954, Table II, Fig. 3).

Stomach (ventriculus)

The caudal part of the oesophagus continues in the stomach. It is somewhat bent and situated medially. On its inner surface, the plicae of oesophagus are running.

TABLE I

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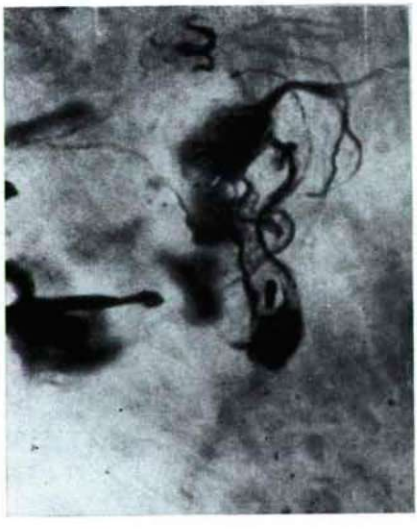

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Fig. 1. *Rana ridibunda:* oesophagus. Mixed nerve-trunk and single unipolar nerve cells in the tunica externa. BIELSCHOWSKY—ÁBRAHÁM's procedure. x 300.

Fig. 2. *Rana ridibunda:* oesophagus. Nerve cells from AUERBACH's plexus. BIELSCHOWSKY—GROS—CAUNA's procedure. x 200.

Fig. 3. *Rana ridibunda:* oesophagus. Cells of types DOGIEL I and II from the plexus myentericus. BIELSCHOWSKY—GROS—CAUNA's procedure. x 400.

Fig. 4. *Rana ridibunda:* oesophagus. Endings on a nerve cell of type DOGIEL I. BIELSCHOWSKY—ÁBRAHÁM's procedure. x 675.

Its histological structure is more complicated than the rest of the oesophagus because the mucous muscular layer appears in the stomach with two layers, as well as the submucous tunic dividing it from the muscular tunic.

In the external histological layer of stomach — the tunica serosa — we find nerve-trunk consisting more or less of fibres that are the thickest at the cardia but, owing to bifurcations, they grow quite thin in the pylorus region. It is very difficult to separate the impregnated myelinated and non-myelinated fibres from each other in the smaller nerve-trunks while the myeline sheath becomes gradually so thin that it could be distinguised from the other vegetative fibres only with a special staining procedure applied with great routine. The smaller bundles bifurcating from the major nerve-trunks run over to the longitudinal muscle layer of muscular tunic, and they are mixed with the fibres of AUERBACH's myenteric plexus which innervate both muscle layers. Another part of fibres end in the mucous tunic and in the muscular mucous tunic.

The plexus myentericus Auerbachii contains nerve cells DOGIEL I and II types but type DOGIEL II appears in greater numbers (Table II, Fig. 4). The nerve cells are set generally one by one, but at the bifurcation, and at the meeting points of the nerve bundles they come in twos (Table III, Fig. 1).

It is not decided, as yet, on the basis of literary date whether the fibres of the myenteric plexus run over to the submucous tunic or not. Our finding reveals that some of the smaller nerve trunks, and single nerve-fibres, too, run over to the submucous tunic (Table III, Figs. 2, 3). This generally takes place beside the smaller vessels and capillaries. We think possible, that these nerve-fibres take part not only in the innervation of blood vessels but also in the glands of the mucosa and submucosa (IWANOW, RADOSTINA, 1937).

In the initial section of the stomach the MEISSNER's plexus contains nerve cells, however, in the fundus and pylorus these are none. We have found a great number of smooth-edged fibres in the nerve trunks and several thicker fibres of meandering course, too, that lost their myeline sheaths. They run, after their dichotomical branching partly to the glandular cells (Table III, Fig. 4), and partly to the simple columnar epithelium. In this way, the end-branches of fibres end on the basal part of the cells (SALAMON, 1955).

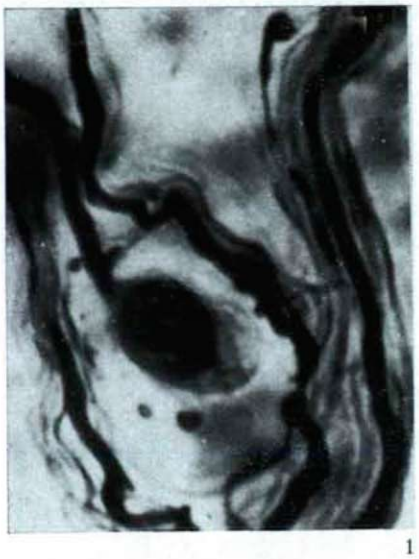
Study of the acetylcholinesterase activity

In the plexuses of the oesophagus and stomach the nerve cells and the nerve fibres show a cholinesterase activity of different degrees (DONHOFFER, 1959; Table IV, Fig. 1). In the myenteric plexuses of the fundus and the

Table II

Fig. 1. *Rana ridibunda:* oesophagus. Unipolar nerve cell in the lamina propria. BIELSCHOWSKY—GROS—CAUNA's procedure. x 450.
Fig. 2. *Rana ridibunda:* oesophagus. End-rings on the nerve cells of type DOGIEL I. BIELSCHOWSKY—GROS—CAUNA's procedure. x 400.
Fig. 3. *Rana ridibunda:* oesophagus. Innervation of the glandparenchyma. BIELSCHOWSKY—ÁBRAHÁM's procedure. x 150.
Fig. 4. *Rana ridibunda:* fundus. Nerve cell of type DOGIEL II from the plexus myentericus. BIELSCHOWSKY—ÁBRAHÁM's procedure. x 500.

TABLE II



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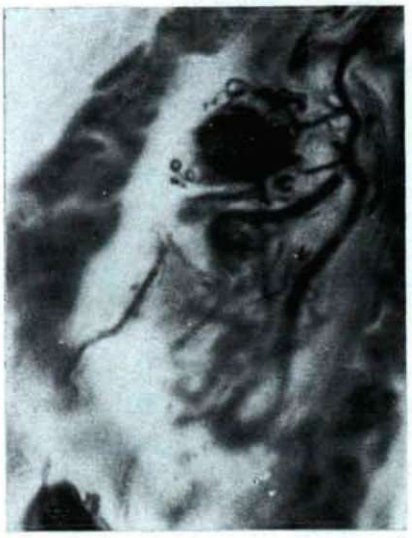

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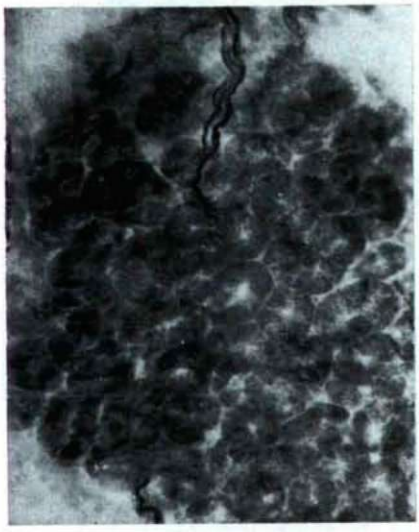

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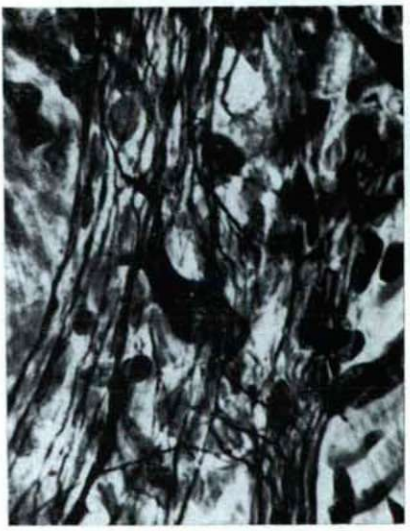

TABLE III

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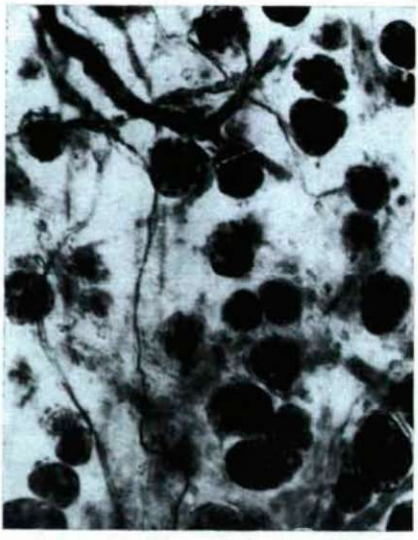


pylorus cell bodies of DOGIEL I and II types showed a weak acetylcholinesterase activity. On the other hand, in the oesophagus and cardia, besides the uni- and bipolar nerve cells, there are also multipolar nerve cells of DOGIEL I types which showed a diffuse positive reaction not only in the cell body but in the cell processes, too. On the basis of this, they may get impulses through the preganglionic fibres of the spinal cord while others from the motor nuclei of the vagus in the medulla oblongata. We try to prove the above mentioned datum by the impregnated preparations made from these intestinal tracts, where we can see numerous end-rings and end-knobs around the cells of DOGIEL I type (Table I, Fig. 4, and Table II, Fig. 2). We consider to be verified the vagal origin of some of these cells if we accept the results of MÜLLER's investigations (cit. ÁBRAHÁM, 1936) concerning the embryonal vagus of vertebrates according to which nerve cells of the central vagal system migrate to the intramular intestinal plexuses. So the acetylcholinesterase appear in some cells in the cranial section of the intestinal tract because they belong to the parasympathetic vagal system and in other cells in consequence of the transfer of stimuli. According to our supposition, the cells of DOGIEL I types may be partly sympathetic, partly parasympathetic motor cells. It was established by OKINAKA et al. (1967), on the basis of demonstrating acetylcholinesterase and monoamino-oxidase in the oesophagus, that in addition to the cholinergic mediation, a strong adrenergic mechanism was effective, as well. The uni- and bipolar nerve cells occuring in these plexuses have sensory function according to our supposition (IWANOWA, 1952).

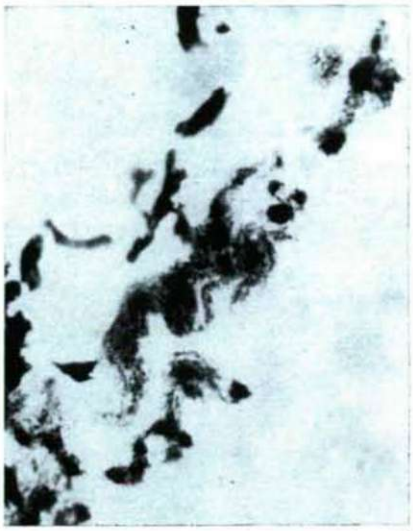
The nerve-fibres leaving these plexuses show acetylcholinesterase activity in the other histological layers of the oesophagus and stomach, as well. The intensive brown granules among the smooth muscle cells may be the transmitter sites of the neuromuscular stimulation (Table IV, Fig. 2). Dark brown granules appear on the membranes of the glandular and epithelial cells, too (Table IV, Figs. 3, 4). We consider these granules to be the transmitter sites of stimuli of the secretory, and intraepithelial nerve fibres.

We cannot separate histochemically the sensory system of the intestinal tract. Its cause is that the differences between acetylcholinesterase activities of the afferent and efferent cholinergic nerves cannot be demonstrated. A number of investigators have already drawn the attention to that fact. They have established that, e. g., both the sensory nerve fibres of the spinal cord (CSILLIK et al., 1954) and the depressor fibres of vagal origin (ÁBRAHÁM, 1956) similarly show an acetylcholinesterase activity. On this basis we do not exclude the possibility that in the oesophagus and stomach of the marsh-frogs sensory fibres of vagal and spinal origin may also occur.

Table III

Fig. 1. *Rana ridibunda:* fundus. Nerve cell of type DOGIEL II from AUERBACH's plexus. BIELSCHOWSKY—ÁBRAHÁM's procedure. x 300.
Fig. 2. *Rana ridibunda:* fundus. Innervation of muscle and submucosa. BIELSCHOWSKY—ÁBRAHÁM's procedure. x 200.
Fig. 3. *Rana ridibunda:* pylorus. Innervation of capillaries in the submucosa. BIELSCHOWSKY—ÁBRAHÁM's procedure. x 550.
Fig. 4. *Rana ridibunda:* fundus. Nerve-plexus in the glandular parenchyma. BIELSCHOWSKY—GROS—CAUNA's procedure. x 150.

TABLE IV



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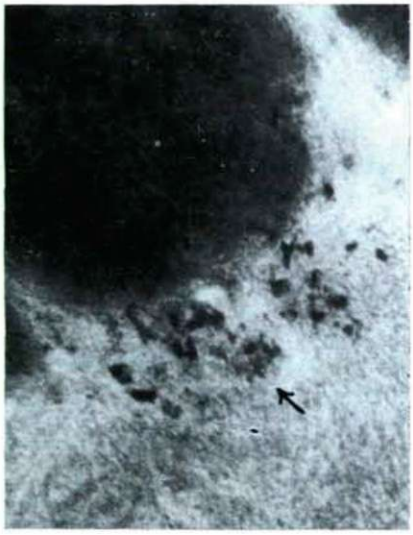

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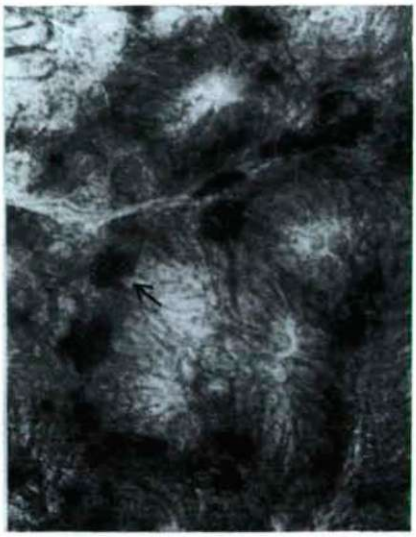

Summary

The results of our examinations carried out on the oesophagus and stomach of the marsh-frog (*Rana ridibunda* PALL.) can be summarized as follows.

1) From the histological layers of the oesophagus, the tunica muscularis mucosae and tunica submucosa are missing. MEISSNER's plexus containing mostly unipolar nerve cells takes place in the lamina propria. In AUERBACH's plexus, besides the unipolar nerve cells, nerve cells of type DOGIEL I occur in high numbers, on which synaptic end-rings and end-knobs can be observed.

2) In the nerve-fibre plexus of the tunica submucosa of stomach we have not found any nerve cells. The nerve cells of the plexus myentericus AUERBACHII are mostly of type DOGIEL II. We have not seen any synaptic endings on these cells.

3) In the innervation of oesphagus and stomach, apart from the vegetative neurons of the intestinal tract, there take part the cerebrospinal nerve-fibres, as well. These occur in the tunica externa in thicker, in the tunica serosa in thinner nerve trunks.

4) The nerve cells and nerve-fibres of the oesophagus and stomach show an acetylcholinesterase activity of changing intensity. The nerve cells of the plexuses, on the basis of the differences in forms and activites, are partly of sympathetic and partly of parasympathetic in origin.

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Table IV

Fig. 1. *Rana ridibunda:* oesophagus. Acetylcholinesterase activity in the plexus myentericus. KOELLE—FRIEDENWALD's procedure. x 150.

Fig. 2. *Rana ridibunda:* cardia. Acetylcholinesterase activity in the tunica muscularis. Thioacetic-acid procedure. x 200.

Fig. 3. *Rana ridibunda:* oesophagus. Acetylcholinesterase activity in the tunica mucosa. Thioacetic-acid procedure. x 200.

Fig. 4. *Rana ridibunda:* cardia. Acetylcholinesterase activity on the basis of epithelial cells. Thioacetic-acid procedure. x 300.

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SUPPOSITION OF GENETIC CONNECTIONS OF BRONZE-AGE FINDS ON THE BASIS OF BLOOD-GROUPINGS

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On the occasion of palaeoanthropological investigations, it is more and more required of the research workers to-day to perform a biological reconstruction, too, of the population studied. By means of the usual metric and morphologic methods that task cannot be solved completely. We can obtain, anyway, more information about the finds with the complex ostechemical method spreading more and more in this country and applied to the fossil material by I. Lengyel (Lengyel—Nemeskéri, 1963). The advantage of this method is to furnish rather exact information on the age of decease, sex, and blood-groups by means of a quantitative and qualiative determination of the citrate content, inorganic elements of bones, as well as by blood-grouping.

In the cemetery from the late Bronze Age excavated in the findspot Széntéglaégető, in the vicinity of the village Tápé beside Szeged (Southern Hungary), as well, these determinations have been carried out by I. Lengyel. Here we do not want to treat fully the results of that as they will be contained in the monograph about the cemetery, in the publication of the much more authentic author.

It is to be mentioned, at any rate, concerning the material that in the cemetery the decomposition of finds was at a very much advanced stage, we have succeeded, therefore, in performing the taxonomical analysis only on eighty-one individuals from the 579 graves excavated (Farkas—Lipták, in the press). We had therefore to look for another way for revealing the connections. It seemed to us to be suitable for that an observation according to which the presence or absence of sixteen morphological characteristics occured alternately in the finds. After marking these characteristics to the single graves, we found that some characteristics were missing from some graves close to one another, that is to say, from a larger area of the cemetery or, on the other hand, they occur — as distinguished from the graves lying in the adjacent area.

As a concequence of this realization, the author of the present paper has divided the cemetery into thirteen smaller areas that — in his opinion — can be demarcated well. He has supposed that these may have been burial-places of clans. On that basis, however, it was also to be supposed that within these clannish areas there had been buried more families.

After a more intensive observation it turned out that there might be found grave-groups consisting of four to eight graves and placed approximately in the shape of an ellipse withing the burial-place of clan, and on them there could be observed some morphological characteristics that were missing from the finds of the adjacent graves. We cannot verify, of course, the genetic connection of these graves on the basis of morphological characteristics.

As, anyway, I. Lengyel was so good to make the results of his ABO blood-group determination of the finds available for us, these connections seem — at least in the cases investigated so far — to be doubtless. Our supposition is based on the following.

We have learned from the investigations of the establishment of ancestry what kind of blood-groups the children of parents of a given blood-group may have. We are mentioning in this regard the following arrangement (FEHÉR—FARKAS, 1956):

Mother	Child	Father	
		possible	impossible
O	O	O, A, B,	AB
A	O	O, A, B,	AB
B	O	O, A, B,	AB
O	A	A, AB	O, B
A	A	O, A, B, AB	—
B	A	A, AB	O, B
AB	A	O, A, B, AB	—
O	B	B, AB	O, A
B	B	O, A, B, AB	—
AB	B	O, A, B, AB	—
A	AB	B, AB	O, A
B	AB	A, AB	O, B
AB	AB	A, B, AB	O
A	B	B, A	O, A

Knowing these connections, and selecting three grave-groups on the basis of the cemetery map, we have got the following result:

1. At the North-Western end of the cemetery, there are placed the following graves:

grave 351: male of 40—50, blood-group: AB
grave 353: male of 40—50, blood-group: A
grave 354: female of 20—30, blood-group: B
grave 355: male of 30—40, blood-group: B

On the basis of the evaluation data of the skeletons, there are possible two alternatives (Fig. 1).

a) According to one of them, they may have been brothers, resp. sisters. In that case it is to be supposed that one of the parents was of blood-group B and the other of blood-group AB.

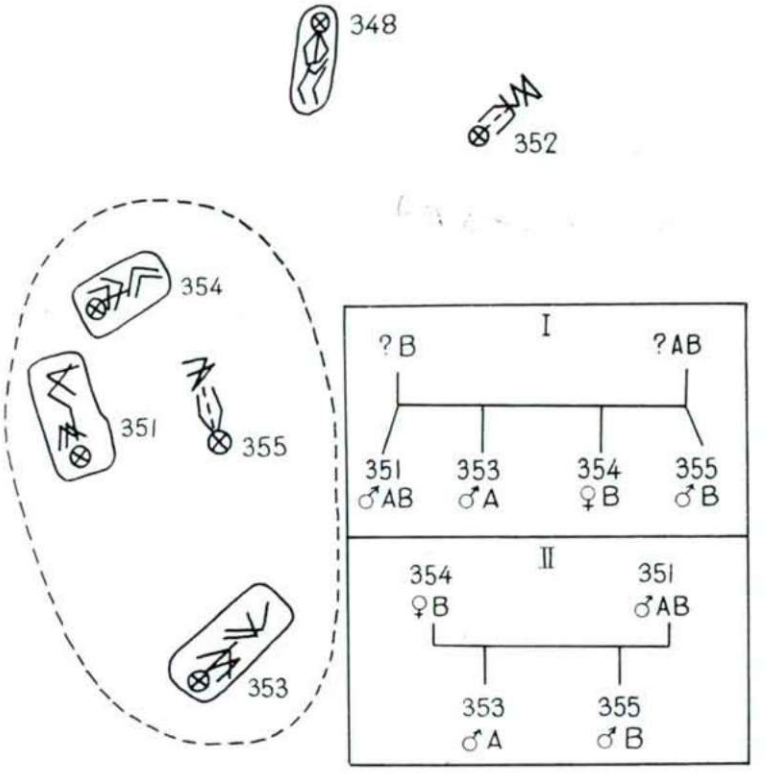

Fig. 1

b) According to the other possibility, the parents are represented by the female find of grave 354 and the male find of grave 355; their descendants may have been the individuals buried in graves 353 and 355.

Both alternatives are possible on the basis of the blood-groups connections given above.

2. In the middle line of the cemetery, directed NW—SE, on the NW side of the cemetery, there are placed the following graves:

grave 373: female of 15—25, non secreter (NSe)
grave 374: male of 22—40, non-secretor (NSe)
grave 388: female of 20—30, blood-group: O
grave 389: child of 0—7, blood-group: 0
grave 416: male of 40—50, blood-group: O
grave 609: male of 20—30, blood-group: O
grave 610: female of 25—35, non-sectretor (NSe)

On the basis of data at our disponal we are suppasing that the female individual of grave 610 and the male one of grave 416 were the parents having, in the sense of the above-mentioned data, five descendants (Fig. 2). The relationship is particularly proved by this group: a mother of blood-group O and a father of blood-group O can namely have only a child of

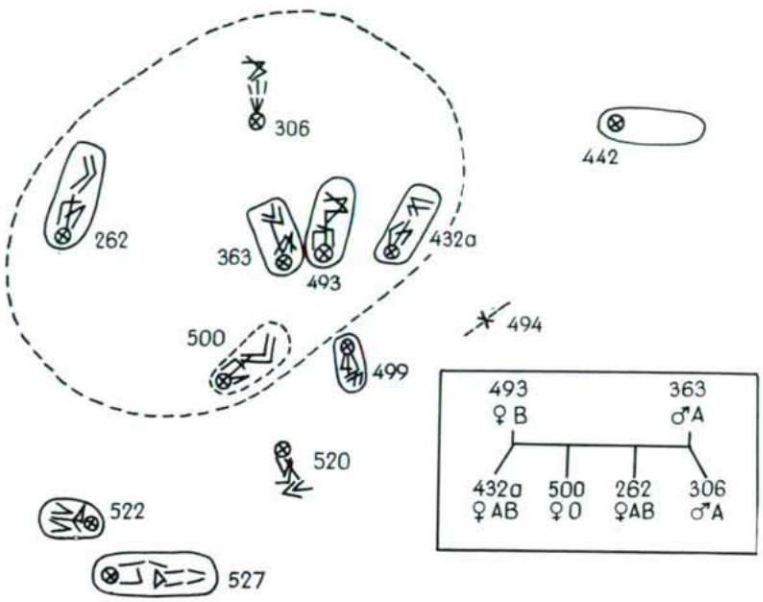

Fig. 2

blood-group O. The finds of the five graves mentioned either belong to blood-group O or they are „non-secretors" that is to say, there is ruled out in advance any possibility of their belonging either to blood-groups A, B or to blood-group AB, although their belonging to the blood-group O is not proved, either.

3. At the SE-end of the cementery, there is placed a group consisting of six graves, for which the following data are known:

grave 262: female of 10—15, blood-group: AB

grave 306: male of 20—30, blood-group: A

grave 363: male of 45—55, blood-group: A

grave 432a: female of 30—40, blood-group: AB

grave 493: female of 22—40, blood-group: B

grave 500: female of 25—35, blood-group: O

As to these graves, there may be supposed the following connection (Fig. 3). The parents are represented by the female find of grave 493 and male find of grave 363. They may have had four descendants, *viz.:* the female finds of graves 432a and 500, the male find of grave 306, and the female find of grave 262.

In recpect of the localization of the single graves within the three grave-groups, as well as in that of the summaries supposed we are reffering to the Figures.

As seen from the examples above, there may be supposed family relations within a cementery by means of suitable informations. On that basis, in the described cementery at Tápé from the late Bronze-Age, we could render highly probable the supposition that there had taken place, a burial according to families placing the graves approximatively in the shape of an ellipse. Also more families were buried together, again in a larger area, similarly approximately in the shape of an ellipse, and these families together had obviously formed a common clan.

A more detailed analysis — after suppasing the abovementioned genetic connection — may furnish information also on the general age of life, the number of children in a family, number of families, the age in which the cemetery was in use, the size of population using the cemetery, the incidence of some diseases in the single families, etc.

On the basis of all these, the complex osteochemical investigation elaborated and applied by I. LENGYEL, may therefore prove in concrete cases to be even more efficient and fruitful than expected. In that way, we have got a new method that promotes in high degree the biological reconstruction of the extinct populations.

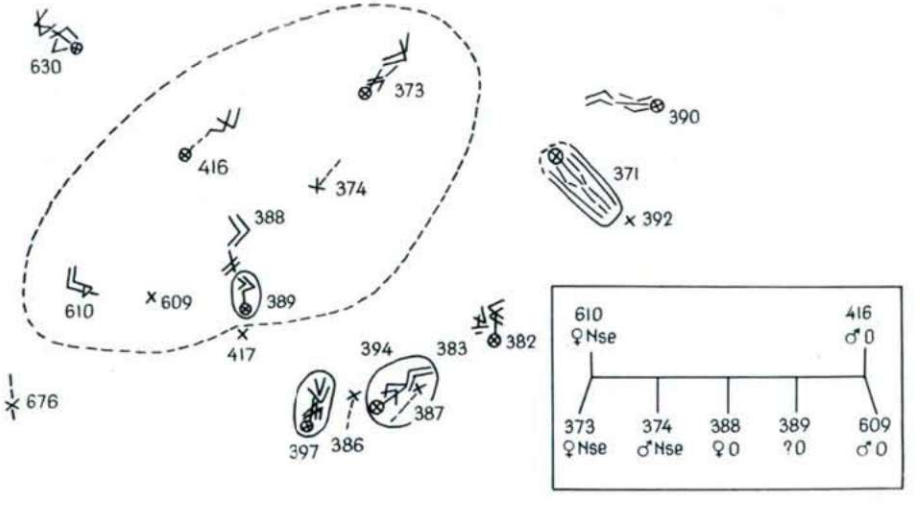

Fig. 3

In case of the mentioned population at Tápé from the late Bronze-Age there is necessary, of course, to get on with evaluating in details the cemetery map. We want to report in details on the results of that evaluation after finishing that work.

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ANTHROPOLOGICAL INVESTIGATION OF THE CEMETERY AT KARDOSKÚT–FEHÉRTÓ FROM THE 11TH–12TH C.

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Introduction

At the Northern shore of the lake Fehértó lying West of Kardoskút there was an excavation as early as in 1895, carried out under the leadership of A. VARGA finding the outlines of a small church. In the environment of the church a large number of skeletons were found (SZÉLL, 1940). The church had been standing on the highest point of the territory whose ground was later occupied by farmhouse No. 389 built in 1921. In the cemetery round the church four new graves were discovered by the Institute of Archaeology of the University in Szeged, in 1943 (OLASZ, 1959). The graves have been of East-West direction, containing the skeletons of two females, one child and one male. Grave finds were only in one of the female graves consisting in two rings and one lock-ring-with S-ending. Furthermore, the existence of a settlement is proved by the traces of an oven and a hearth (BANNER, 1943). Another excavation in the same area led by E. OLASZ in 1949 resulted in further 97 graves. Later on, in 1950, the investigators of the Anthropological Collection of the Museum of Natural History in Budapest joined with them in doing the work digging up graves Nos. 98—146. (I wish to express in this way my thanks to E. OLASZ for passing me the archaeological documentation.) The excavation was continued in the next year, too, resulting in graves Nos. 147—262. „A great part of the multilayer graves was disturbed. Grave finds were: rings with S-ending of different sizes; simple and headed rings; denariuses of the 11th and 12th centuries; iron clasp; knife." (FEHÉR—ÉRY—KRALOVÁNSZKY, 1962). The salvage excavation in 1958 resulted in further 32 graves. The skeletons lay in three layers. At the head of grave No. 25 there was a brick set on edge. The graves are similarly of East-West direction. Grave finds are the same as those uncorved in earlier years (OLASZ, 1959a). This territory is mentioned in SZEREMLEI's monograph (1901) under the name of Apácaegyháza — a village from the Arpadian Age long since extimet. That village existed in the 11th century and was probably destroyed as a consequence of the Tartar invasion of Hungary in 1241—1242. The name of the supposed village was mentioned in 1435 as a lowland plain belonging to János Hunyadi's estate in county Békés (OLASZ, 1959). About the cemetery at Kardoskút—Fehértó in the Arpadian Age there is no detailed archaeological publication so far.

Anthropological elaboration

The anthropological material of the cemetery can be found at present in the Department of Anthropological of the Attila József University (only the excavation finds from 1949/51 and 1958 have been saved). For anthropological elaboration 257 skulls and 160 skeletons sere available for me. From them the number of young and children is 41 (14 per cent). The distribution according to age is as follows: infantia I. 4 (2 p. c.), infantia II. 16 (5 p. c.), juvenis 21 (7 p. c.). Number of males is 136 (46 p. c.), from which adultus 44 (32,3 p. c.), maturus 90 (66,2 p. c.), senium 2 (1,5 p. c.). Number of females: 119 (40 p. c.), broken down according to age-groups: adultus 66 (55,4 p. c.), maturus 52 (43,7 p. c.), senium 1 (0,9 p. c.). Seventy per cent of the material is in good condition containing 181 skulls and 151 skeletons. Their metrical and morphological characterization on the basis of Tables 1 and 2, and taking into consideration MARTIN's method (1928), is as follows.

The *cranium* of males is mesodolichocranic, narrow; on the basis of the mean value and distribution of cranial index dolichocrany is characteristic but also the mesocranic skulls are represented with large numbers. On the basis of basion-bregma height, the mesocephalic skulls are dominant, on the basis of the mean value of the lenght-height index orthocrany is characteristic and according to the breadth-height index metriocrany is. The forehead is narrow; according to its index it is eurymetopic. The outline of skull in vertical norm is mostly ovoid and pentagonoid. The glabella is generally of third degree but degrees four and five also represented in a rather great number. On the basis of their skull capacity they are euencephalic. The facial cranium is middle wide and middle high, on the basis of the mean value of facial index is mesoprosopic and as to its distribution mesoprosopy is represented in equal proportion with euryprosopy. According to the upper facial index, the face is mesene (with regard to the mean value and distribution of the index). Of the facial profile the preponderance of orthognathy is characteristic. The *fossa canina* is deep in middle-sized and minor ratio. The alveolar prognathy is missing or moderate. The orbit is mostly hypsiconch but the ratio of mesoconch orbits is also considerable. The nose is on the basis of the mean value of nasal index mesorrhine and according to its distribution mostly leptorrhine, resp. — in lower number — mesorrhine. The palate is leptostaphylinic. They are moderate in size (165,40 cm).

The *cranium* of female is middle-long, narrow, on the basis of the mean value and distribution of cranial index it is mesocranic, but the dolichocranic skulls are also represented is a rather high number. On the basis of basion-bregma height, the middle-high skulls are dominant; according to the length-height index orthocrany, according to the breadth-height index metriocrany is characteristic, but acrocranic skulls are also represented with a rather high number. The forehead is narrow, on the basis of its index it is eurymetopic, and in a lower percentage metriomtopic. The outline of skull in vertical norm is ovoid and pentagonoid, the *glabella* is mostly of two degrees. On the basis of their cranial capacity they are euencephalic. The *facial cranium* is middle-wide, middle-high; on the basis of facial index mesoprosopy, on that of upper facial index mesene is dominant. The *fossa canina* is generally medium deep,

Table 1. Kardoskút—Fehértó: Distribution of the principal metrical characters

Characters			Males (p. c.)	Females (p. c.)	Total (p. c.)
8 : 1 Cranial index	Ultradolichocranic	x—64,9	1(1,0)	—	1(0,5)
	Hyperdolichocranic	65,0—69,9	6(6,0)	2(2,5)	8(4,5)
	Dolichocranic	70,0—74,9	52(52,0)	34(43,0)	86(48,0)
	Mesocranic	75,0—79,9	39(39,0)	38(48,1)	77(43,0)
	Brachycranic	80.0—84,9	1(1,0)	5(6,4)	6(3,4)
	Hyperbrachycranic	85,0—89,9	1(1,0)	—	1(0,6)
		Total:	100	79	179
17 : 1 Length-height index	Chamaecranic	x—69,9	28(39,4)	11(13,4)	39(29,8)
	Orthocranic	70,0—74,9	31(43,7)	44(73,3)	75(57,3)
	Hypsicranic	75,0—x	12(16,9)	5(8,3)	17(12,9)
		Total:	71	60	131
17 : 8 Breadth-height index	Tapeinocranic	x—91,9	19(26,1)	12(20,3)	31(23,4)
	Metriocranic	92,0—97,9	29(39,7)	25(42,4)	54(41,0)
	Acrocranic	98,0—x	25(34,2)	22(37,3)	47(35,6)
		Total:	73	59	132
9 : 8 Fronto-parietal index	Stenometopic	x—65,9	16(15,8)	14(17,5)	30(16,6)
	Metriometopic	66,0—68,9	26(25.8)	25(31,3)	51(28,2)
	Eurymetopic	69,0—x	59(58,4)	41(51,2)	100(55,2)
		Total:	101	80	181
47 : 45 Facial index	Hypereuryprosopic	x—79,9	—	4(14,3)	4(6,7)
	Euryprosopic	80,0—84,9	12(37,5)	4(14,3)	16(26,7)
	Mesoprosopic	85,0—89,9	12(37,5)	14(50,0)	26(43,3)
	Leptoprosopic	90,0—94,9	5(15,6)	3(10,7)	8(13,3)
	Hyperleptoprosopic	95,0—x	3(9,4)	3(10,7)	6(10,0)
		Total:	32	28	60
48 : 45 Upper facial index	Euryene	45,0—49,9	11(20,8)	5(11,1)	16(16,3)
	Mesene	50,0—54,9	25(47,1)	28(62,2)	53(54,1)
	Leptene	55,0—59,9	16(30,2)	11(24,5)	27(27,6)
	Hyperleptene	60,0—x	1(1,9)	1(2,2)	2(2,0)
		Total:	53	45	98
52 : 51 Orbital index	Chamaeconch	x—75,9	4(5,1)	1(1,8)	5(3,7)
	Mesoconch	76,0—84,9	36(46,2)	27(48,2)	63(47,0)
	Hypsiconch	85,0—x	38(48,7)	28(50,0)	66(49,3)
		Total:	78	56	134
54 : 55 Nasal index	Leptorrhine	x—46,9	27(36,5)	19(35,2)	46(35,9)
	Mesorrhine	47,0—50,9	22(29,7)	21(38,9)	43(33,6)
	Chamaerrhine	51,0—57,9	21(28,4)	11(20,4)	32(25,0)
	Hyperchamaerrhine	58,0—x	4(5,4)	3(5,5)	7(5,5)
		Total:	74	54	128

in lower percentage it is shallow. The alveolar prognathy is moderate. On the basis of facial profile ange they are orthognatic. On the basis of the mean value of orbital index, it is mesoconch, according to its

PLATE I

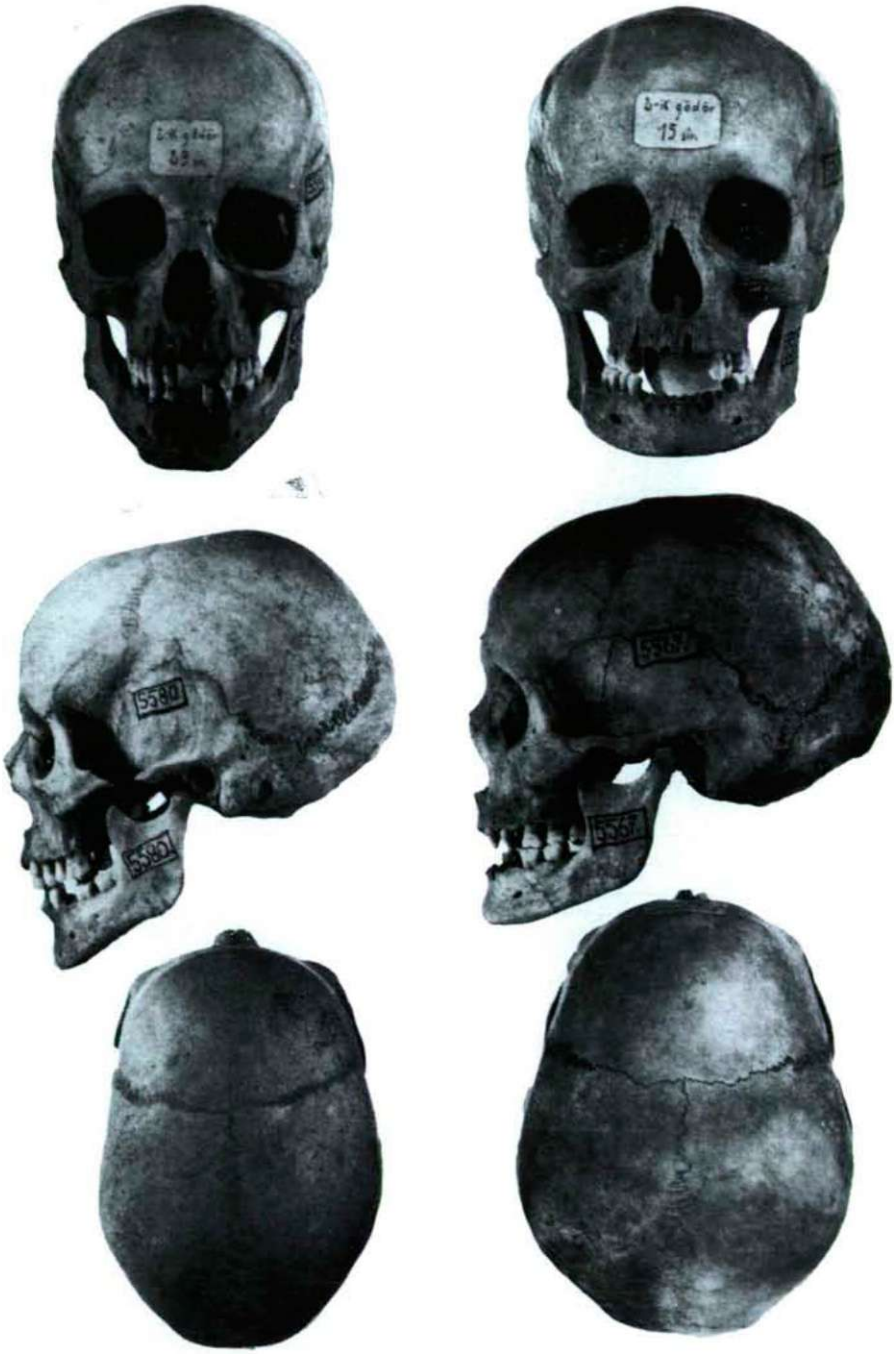

Table 2

Kardoskút—Fehértó: Parameters of the main measurements and indices

No. of measurements (MARTIN)	Males N	Males V	Males M	Males s	Females N	Females V	Females M	Females s
1.	104	170—201	185,1	6,49	83	168—188	178,4	4,92
8.	104	127—153	137,6	5,29	83	124—147	134,7	4,64
9.	109	85—106	96,0	4,61	84	83—102	92,9	4,13
17.	72	120—151	131,8	5,69	63	116—139	128,9	4,95
45.	57	124—149	133,5	5,32	42	119—136	127,2	4,49
47.	47	102—134	117,1	8,05	35	94—129	113,3	7,67
48.	78	59— 84	70,2	5,25	60	60— 78	67,8	3,78
8 : 1	100	64,7— 85,9	74,4	3,67	79	67,8— 81,5	75,3	3,02
17 : 1	71	64,3— 77,8	71,3	3,60	60	64,9— 78,5	72,0	2,67
17 : 8	73	83,3—106,7	96,2	5,37	59	86,7—104,6	96,1	4,43
9 : 8	101	61,0— 76,9	69,8	3,31	80	62,8— 76,7	69,1	2,81
47 : 45	32	81,3— 98,5	87,7	4,62	28	76,6— 97,6	86,9	5,42
48 : 45	53	45,0— 60,5	53,1	3,71	45	46,6— 60,5	53,1	2,95
52 : 51	78	72,7—100,0	85,1	5,51	56	74,4— 92,3	84,7	4,21
54 : 55	74	36,7— 62,0	49,2	5,80	54	37,7— 66,7	49,1	6,81
63 : 62	61	67,3— 92,9	78,1	7,51	41	62,2— 90,9	76,9	5,69

distribution mesoconchy is represented nearly in equal percentage with hypsiconchy. The nasal index, on the basis of its mean value, is mesorrhine, as well as according to its distribution, but the number of leptorrhine skulls is also considerable. The palate is leptostaphylin. They are moderate in size (153,72 cm).

In the light of all these characteristics, there is no any considerable difference between males and females generally; some divergence is only on the basis of the mean value and distribution of cranial index as females have somewhat higher cranial index.

In males, anatomic variations occurred in 34 cases (28 p. c.). These are as follows: *os apicis* appeared in 5 cases (14,7 p. c.), *sutura metopica* in 4 (11,8 p. c.), bones at the lambdoid sutures in 15 (44,1 p. c.), *os epiptericum* in 8 cases (23,6 p. c.), *processus frontalis ossis temporalis* in 1 case (2,9 p. c.), *torus palatinus similarly* in 1 case (2,9 p. c.). At females, anatomic variations could be observed in 33 skulls (31,4 p. c.), their distribution being: *os apicis* in 2 cases (6,6 p. c.), *sutura metopica* in 7 (21,2 p. c.), bones at the lambdoid sutures in 17 (51,5 p. c.), *os epiptericum* in 4 (12,1 p. c.), *torus palatinus* in 2 cases (6,6 p. c.), and *os bregmaticum* in 1 case (3,0 p. c.). Two male skulls were bathrocephalic.

I have carried out the taxonomical analysis of the cemetery according ti P. LIPTÁK's method (1962, 1965). (My special thanks are due to him for his help in my work of analysis.) I omit here the characterization of single

Plate Ia. Kardoskút—Fehértó, 11th—12th century
Grave 29. am. Female.
b. Kardoskút—Fehértó, 11th—12th century
Grave 15. m. Female.

PLATE II

races in details, instead I refer to the works quoted. Considering the data of Table 3, the Nordoid group is in the first place with 35,7 per cent of the population. The group of Mediterraneans is comparatively heterogeneous, its significance is nevertheless similar to that of the former group (33,5 p. c.). (Plates Ia and b, IIb). From the group of *Cromagnoid races*, type *Cromagnon—A* is represented in higher percentage (Plate IIa), while the participation of *Cromagnon—B* is considerably lower. This group lies, as regards the whole population, in the third place, with 29 p. c. Other racial elements are less important (undefinite brachycranic and protomorphous types). In two cases *Mongoloid* traits could be established, however, they are secondary elements.

Table 3

Kardoskút—Fehértó: Taxonomical analysis

Types (races)	Males N p. c.	Females N p. c.	Total N p. c.
Nordoids			
Nordic (n)	29(40,8)	13(27,6)	42(35,7)
Mediterraneans			
Gracile-Mediterranean (m)	6(8,5)	14(29,9)	20(17,7)
Atlanto-Mediterranean(am)	10(14,1)	8(17,5)	18(14,2)
Iranian (i)	—	1(2,0)	1(0,8)
Protomediterranean (pm)	—	1(2,0)	1(0,8)
Total:	16(22,6)	24(51,4)	40(33,5)
Cromagnoids			
Cromagnoid—A (cr—A)	21(29,6)	7(14,8)	28(24,1)
Cromagnoid—B (cr—B)	4(5,6)	2(4,2)	6(5,1)
Total:	25(35,2)	9(19,0)	34(29,2)
Undeterminable brachycranic component (br)	1(1,4)	—	1(0,8)
Protomorphic compotent	—	1(2,0)	1(0,8)
Total:	71	47	118

Summary

On the basis of the taxonomical analysis, the cemetery can be considered as moderately heterogeneous. Between males and females there is no considerable difference on the basis of the taxonomical analysis. The only divergence is in the case of males where after the *Nordic* group the *Cromagnoid* ones are in the second place, with a preponderance of type *Cromagnoid—A*,

Plate IIa. Kardoskút—Fehértó, 11th—12th century
Grave 98. crA Male.
Kardoskút—Fehértó, 11th—12th century
Grave 31. am. Male.

while the third place is represented by the *Mediterraneans* (with a great percentage of the type *Atlanto-Mediterranean).* In the case of females, however, the *Mediterranean* group is in the first place, with a preponderance of the gracile *Mediterraneans,* while the Nordoid ones come in the second place and the *Cromagnoid* ones are only in the third place. We have several anthropological publications concerning the South Hungarian Plain (LIPTÁK—FARKAS, 1962, 1967, 1967a; FARKAS—LIPTÁK, 1967), according to which the dominant race components are the *Nordic* one, the *Mediterranean,* and the *Cromagnoid—A.* The population of Kardoskút—Fehértó in the *Arpadian-Age,* if analysed taxonomically is fully corresponding to the anthropological material of the quoted cemeteries in the South Hungarian Plain.

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TWO NEW SPECIES OF SULCOMESITIUS MÓCZÁR (HYM., BETHYLIDAE)

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(Received December 18, 1969)

The genus *Sulcomesitius* was established by the author (Acta Zool. Hung., 16, 1970) and all the other species belonging to this genus are to be found in „*Mesitinae* of World, Part II. (also in Acta Zool. Hung., 16, 1970). Moreover, the following new species were taken in Persia and in Senegal (W. Africa).

Sulcomesitius persicus sp. n.

♀. — Legnth 3 mm. Yellowish brown, propodeum, subpleural area nearly whole middle and hind coxae and abdomen dark reddish brown, abdominal segments 3—6 brownish. Wings normal, fore wings brown infuscated with basis, apex and a spot outside of cells lighter. Body sparsely covered with short light hairs.

Head slighly longer than broad (34 : 32), distinctly broadened behind eyes, lateral sides gradually converning backwards, occipital margin emarginated; head deeply and rather densely punctured, spaces between punctures only finely shagreened; POL: OOL = 5 : 7; outer margins of ocelli with narrow but distinct grooves; frontal sulcus distinct; eye very convex, oval, separated from mandible by about an equal distance of its half length (7 : 6,5); anterior margin of clypeus semicircularly protruding and with a very spharp and high keel medially; antennae not thickened medially, lenght (and breadth) proportions of antennal joints 1—13 = 13(4) : 5(2,5) : 6(2,5) : 3,5(2,5) : 3(3) : 3(3) : 3(3) : 3(3) : 3(3) : 3(3) : 3(3) : 3(3) : 5(3) (antennal joints of right 11—13 and of left 1—7 missing. Pronotum rather long, about three-quarters as long as broad, lateral sides remarkably concave, posterior margin only slightly emarginated, longitudinal furrow deep but rather narrow, surface coarsely but not very deeply punctured. Mesonotum, scutellum smooth only weakly shining, notauli deep, longitudinal furrow sharp medially and present also across scutellum. Mesonotum separated from scutellum by a transverse groove and by a pair of pits laterally. Propodeum with only slightly diverging lateral sides, posterior angles acute, separate spine very short visible only from back-view, half diameter of propodeal disc as broad as length of propodeum (13 : 13), width of central: sublateral: lateral areas =

5 : 7 : 3, surface of disc strongly sculptured, sublateral and lateral areas transversally wrinkled, all carinae present, discal ones strongly converging at proximal halves, and parallel distally. Abdomen smooth, shining, tergite 2 alutaceous basally and anly with very fine and scattered punctures.

♂. — Unknown.

Specimen examined: „K. Sefid", „S. W. Persia Escalera, 1900—61" 1 ♀ holotype (in British Museum [Natural History], London).

This species differs from *Mesitius bahaduri* KURIAN, 1955, by partly yellowish brown body, by longitudinal impressed scutellum, by abdominal tergite 2 with very fine and scattered punctures and by lateral angles of propodeum acute, spine hardly protruding.

Sulcomesitius linsenmaieri sp. n.

♀. — Length 7 mm. Yellowish red, eyes, ocelli, a spot within lateral spines of propodeum yellowish red, 4—13 joints of antennae partly, and tibiae partly brownish, propodeum, a spot before middle coxae, hind coxae and abdomen black. Fore wings brownish infuscated with lighter basis and apex and with a hyaline transversal band outside of cells, veins brown. Body, also eyes, covered with scattered light hairs, abdominal segment 1 only laterally, segment 2 on posterior margin with a distinct row of tuft of white hairs.

Head slightly oval, length and breadth of head as 60 : 55; lateral sides distinctly converging, occipital margin weakly arched; head closely and deeply punctured, similar to a thimble, frontal sulcus only weakly developed; POL: OOL = 10 : 11; outer margins of ocelli with very deep grooves; eye elongated, separated from mandible by about two-thirds distance of its length (16 : 23); anterior margin of clypeus protruding semicircularly and raised into a high, sharp and very steep keel medially; antennae short, hardly thickened medially, scape bent, joints 1—3 distinctly longer than broad, 4 quadrate, 5—10 transverse, length (and breadth) proportions of joints 1—13 = 20(7) : 7(5) : 10(6) : 6(6) : 5(6,5) : 5(6) : 5(6) : 4(5) : 4(5) : 4(5) : 4(4) : 4(4) : 6(4). Pronotum distinctly broader than long (43 : 35), lateral sides slightly diverging, anterior corners nearly rectangular, posterior margin nearly straight, longitudinal furrow sharp and very deep, surface of pronotum coarsely and very deeply punctured, narrow spaces between punctures finely shagreened. Mesonotum, scutellum deeply and rather densely punctured, with deep longitudinal furrow medially, as well as, notauli which strongly converging, parapsidal furrows weakly developed. Transversal groove between mesonotum and scutellum narrow and deep but distinctly broadened laterally, scutellum with a short deepening, only basally. Propodeum conspicuously short, and coarsely sculptured, half diameter of disc transversally nearly one-third broader than its length (28 : 20); lateral spines very long, three-fourths as long as length of propodeum (15 : 20); breadth of central: sublateral: lateral areas = 10 : 11 : 7; proximal-diagonal deepenings of central areas distinctly shorter than distal-longitudinal deepening (12 : 14); distal half of each central *area* only with two very large and two smaller pits; distal carinae parallel on its distal half; sublateral areas transversally wrinkled; sides of thorax coarsely

sculptured. Abdominal segment 1 deeply and rather densely punctured on its two-thirds horizontal part proximally and smooth, polished distally, segment 2 deeply and very densely punctured among punctures with some smaller ones.

♂. — Unknown.

Specimen examined: „Senegal Bambey 1946 I. Risbec", „Pres. By Com. Inst. Ent. B. M. 1950—96", „*Heterocoelia* DHLB. (*Mesitius* sp.) spec. det. LINSENMAIER" 1 ♀ holotype (in Brit. Mus. [Nat. Hist.], London).

This species is similar to *nasutus* BENOIT, 1958, but differs from it chiefly by the denser and more uniform punctures of abdominal segment 2, by the sculpture of central areas, by the parallel discal carinae on its distal half.

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